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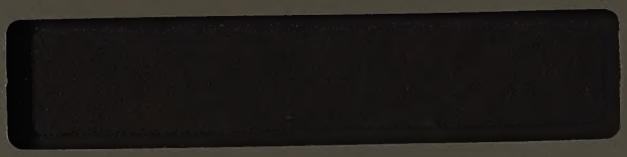

SYSTRON DONNER
Member THORN EMI Group

HFP 500-1

INSTRUMENT DIVISION

PROGRAMMABLE POWER SUPPLIES

DOCUMENT NO. 120073-51

OPERATING AND SERVICE MANUAL

2727 Systron Drive • Concord, California 94518 • U.S.A.
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FSCM No. 52542

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SYSTRON DONNER
INSTRUMENT DIVISION
2727 Systron Drive
Concord, California 94518

WARRANTY POLICY

I Warranty

Systron Donner Instrument Division warrants that at the time of shipment the products manufactured by Systron Donner and sold hereunder will be free from defects in material and workmanship and will conform to the current specifications published by Systron Donner's Instrument Division.

II Warranty

A **The warranty period will be one year from the date of shipment. This warranty is extended only to the original buyer.**

III Warranty Adjustments

A. If any defect within this warranty appears, Purchaser shall notify Seller immediately.

B Systron Donner agrees to repair or furnish a replacement for, but not install, any product which within the standard warranty shall, upon test and examination by Systron Donner, prove defective within the above warranty period.

C No product will be accepted for return or replacement without prior approval of Systron Donner. Upon such authorization and in accordance with instructions of Systron Donner, the product will be returned to the manufacturing location, shipping charges prepaid by Purchaser.

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B Systron Donner will not be liable for any special or consequential damages or for loss, damages or expense directly or indirectly arising from the use of the products, or any inability to use them either separately or in combination with any other equipment or material, or from any other cause.

C The warranty does not extend to any product manufactured by Systron Donner which has been subjected to misuse, neglect, accident, improper installation or to use in violation of instructions furnished by Systron Donner.

D The warranty does not extend to or apply to any unit which has been repaired or altered at any place other than Systron Donner; by persons not expressly approved by Systron Donner; not to any unit, the serial number of which has been removed or defaced or Changed.

E This warranty applies to new equipment only and will cover repaired or replacement items only to the extent of the balance remaining of the items original warranty period noted in Paragraph II.

F All freight charges will be paid for by the Purchaser.

June, 1985

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(Revision/Configuration Control Document)

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SAFETY PRACTICES

Personnel assigned to the operation or maintenance of the HFP500-1 Power Supply are encouraged to review the safety practices given in this section. These are recommended procedures which may prevent a serious accident, save a life, or protect the instrument from damage.

Whenever the safety of operating or maintenance personnel is involved, special safety instructions are inserted in the text as "WARNINGS". Instructions concerning the safety of equipment are inserted as "CAUTIONS". These notations are discussed in greater detail at the end of this section.

The following recommended procedures should be understood and applied during any phase of operation or maintenance of this equipment:

CHASSIS GROUNDING

Prior to applying power to the unit. determine that the internal protective power ground is connected to the protective ground conductor of the power cord. This ground, in turn, must be connected through the external power cord to the grounded power outlet. (Verify ground continuity using an ohmmeter, with power totally removed from the instrument.)

a. Any interruption of the protective ground conductor, inside or outside of the power supply, could create a potentially hazardous condition due to possible (chassis) voltage differences between this and other equipments. When connected into a system with other units, all power grounds should connect through a common bus to optimize circuit breaker response in the event of electrical failure. Intentional interruption of the grounding system by the use of two-wire plug adapters or two-wire extension cords must be considered an unsafe practice.

b. Whenever it is determined that the protective ground system has been impaired, the equipment must be made inoperative or be secured against inadvertant operation until the deficiency is corrected.

KEEP AWAY FROM LIVE CIRCUITS

Operating and maintenance personnel are cautioned against using the power supply with cover panels removed and power applied, unless directed to do so by a specific instruction manual procedure (troubleshooting, calibration, etc).

a. Under certain conditions, dangerous potentials may still exist when power is removed from the instrument due to charges retained by capacitors. To avoid injury, always remove power; then, discharge or ground any large capacitors prior to replacing components or making repairs.

b. To avoid potential damage to the power supply, always remove power from the instrument before extracting or inserting any circuit boards and/or discrete components.

c. Troubleshooting, repair, or adjustments of the power supply with power applied to the circuits should be minimized whenever possible. However, when instruction manual procedures so dictate, these should be performed only by skilled technical persons who are aware of the various hazards involved.

DO NOT SERVICE OR ADJUST ALONE

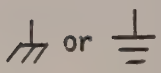
Under no circumstance should any person service or adjust equipment unless in the presence of another person who is capable of rendering first aid/resusitation services in the event of an accident.

DEFECTIVE PARTS REPLACEMENT

To avoid possible damage or degrading of instrument performance, technical personnel are cautioned to replace defective components only with new factory replacement items; or, in certain cases, cross-referenced, direct-substitute items. Be certain that only the correct power fuse with required rating (voltage/current) and specified type (fast blow, slow blow, etc) is used for replacement purposes. The use of repaired fuses or short circuiting of the fuseholder is considered an unsafe practice.

SAFETY SUMMARY

The following safety and special symbols are used on the HFP500-1 Power Supply and/or in this manual.


Indicates earth (ground) terminal

Indicates A1 Control PCB power common

Indicates signal common

WARNING

The **WARNING** sign denotes a personnel hazard. It calls attention to a procedure or practice, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a **WARNING** sign until the indicated conditions are fully understood and met.

CAUTION

The **CAUTION** sign denotes an instrument hazard. It calls attention to an operating procedure or practice, which, if not correctly performed or adhered to, could result in damage to, or destruction of part of all of the instrument. Do not proceed beyond a **CAUTION** sign until the indicated conditions are fully understood and met.

Warning and Cautions appearing in the text of this instruction manual are repeated here for review and emphasis by personnel operating or maintaining this instrument.

WARNING

Before applying power, ensure that the protective ground terminals of the power supply module is connected to the protective conductor of the (mains) power cord. The cord plug shall only be inserted into an outlet provided with protective ground contact. The protective conductor must not be negated by the use of an extension cord without a protective grounding conductor.

WARNING

Under worst case conditions of high line voltage, no load and maximum RC time, it could take 32 seconds to discharge the capacitors to a non-hazardous potential of less than 42 volts. Always wait at least 1 minute after power is removed or use a shorting bar before attempting to service the power supply.

Page 3-1

WARNING

Performance of the following procedures exposes the technican to possible contact with 600 volts. Use caution and follow the procedures as written.

CAUTION

Certain components within the power supply can be damaged by use of carbon-based solvents. Avoid use of chemicals that contain acetone, benzene, tuluene, xylene, petroleum ether, kerosene, carbon tetrochloride, methylene, chloride, and trichlorotrifluoroethane (i.e., freon 113, -tf-tatme). Recommended agents for interior cleaning are isopropyl alcohol or kelite (1 part kelite to 30 parts water). It is safe to use ethyl alcohol and methyle alcohol if the recommended solvents are not available.

Page 4-1

WARNING

Before appling power to any unit of the test configuration, ensure that the protective ground terminals of the UUT and the test equipment are connected to the protective conductors of the (mains) power cords. The power cords plugs shall only be inserted into outlets provided with protective ground contacts.

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CHAPTER 1

GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This operating and service manual contains information relating to the installation, operation, maintenance and calibration of the Systron Donner HFP500-1 Power Supply.

1-3. The information contained in this manual is divided into front matter and six descriptive chapters, indicated in the following format.

Front Matter: includes the title page, warranty policy, proprietary rights statement, list of effective pages, table of contents, list of figures, list of tables and safety practices information.

Chapter 1 - General Information: contains a general description of the HFP500-1 Power Supply and safety practices.

Chapter 2 - Installation and Operation: describes unpacking and receiving inspection, installation criteria, system interface with the P6/P12 Programmers, power requirements, connection to loads and/or units under test (UUT). Instructions on preperation for reshipment is also provided.

Chapter 3 - Principles of Operation: provides a functional description of the HFP500-1 Power Supply and is referenced to schematic diagrams located in Chapter 6 of this manual.

Chapter 4 - Maintenance: describes the steps required for routine maintenance, inspection, alignment and performance verification.

Chapter 5 - Replaceable Parts: component parts are listed in this chapter along with parts ordering information and manufacturer's code-to-name index.

Chapter 6 - Drawings: provides technical personnel with the required schematics and component location diagrams to support maintenance and troubleshooting of the HFP500-1 Power Supply.

1-4. EFFECTIVITY OF MANUAL

1-5. Information contained in this operating and service manual is date-coded at the bottom of each page. A summary of these date codes is given in the list of Effective Pages (A page) located within the front matter of this manual. Any future changes to this manual will be reflected in the List of Effective Pages.

1-6. DESCRIPTION

1-7. The HFP500-1 Power Supply is modular in design to allow a compact multiple output programmable system configuration for use in automatic test equipment (ATE) systems when used in conjunction with the the P6/P12 Programmers. The P6/P12 Programmers will allow up to thirteen power supplies to be controlled via a General Purpose Interface Bus (GPIB) which conforms to IEEE Std 488-1978. Refer to "P6/P12 Programmer Operating and Service Manual" Systron Donner document number 120071-01 for detailed information on the Programmer.

1-8. The HFP500-1 Power Supply module is a compact, precision, dissipative regulator, housed in a half rack chassis thus, allowing a compact multiple output rack assembly. Systron Donner RA4 rack assemblies provide the rack mounting for the power supplies and their associated P6/P12 Programmers.

1-9. SPECIFICATIONS

1-10. Table 1-1 provides the performance specifications of the HFP500-1 Power Supply.

Table 1-1. HFP500-1 Power Supply Specifications

Parameter	Stabilization Mode	
	Voltage	Current
PROGRAMMABLE RANGE: the obtainable range that can be programmed.	0 to 500 V	0 to 1 A
DRIFT: the output drift over 8-hours under constant line, load and temperature after a 30-miniute warm up.	25 mV	250 µA
PARD: periodic and random deviations from stabilized output, measured from 20 Hz to 4 MHz.	10 mV rms	500 µA rms
LOAD EFFECT: the change in stabilized output caused by a load change equal to the output rating.	1 mV Typical 5 mV Maximum	1 mA
SOURCE EFFECT: the change in stabilized output caused by any change in the ac line within the input rating.	1 mV Typical 5 mV Maximum	100 µA
TEMPERATURE EFFECT: the change in stabilized output per °C in ambient temperature, over the operating range of 0°C to +50°C.	25 mV	100 µA Typical 200 µA Maximum
V_{LIM} PROGRAMMAGLE RANGE: the obtainable voltage limit range.	5 to 550 V	

1-11. ENVIRONMENTAL AND PHYSICAL CHARACTERISTICS

1-12. Table 1-2. lists the environmental and physical characteristics of the HFP500-1 Power Supply. Figure 1-1 provides outline drawing with dimensional data.

Table 1-2. HFP500-1 Environmental and Physical Characteristics

Storage Temperature:	-40 to +75°C
Operating Temperature:	0 to 50°C
Operating Humidity:	5 to 85% relative, noncondensing
Vibration (MIL-STD-810):	0.33 mm at 5 to 55 Hz
Power:	115/230 V rms ±10% 47 to 63 Hz 800 Watts maximum

Table 1-2. HFP500-1 Environmental and Physical Characteristics (Cont'd)

Dimensions:	
Height:	13.25 cm (5.22 in)
Width:	21.27 cm (8.375 in)
Depth:	47.93 cm (18.87 in)
Front Panel Handle Projection:	3.81 cm (1.50 in)
Weight:	
Shipping:	18.5 kg (40 lbs)
Net:	15.8 kg (35 lbs)

1-13. SAFETY PRACTICES

1-14. Prior to operation or maintenance of a HFP500-1 Power Supply technical personnel are encouraged to review the safety practices section located in the front mater of this manual. Removal of the cover panels while the power supply has line power applied, exposes personnel to possible contact with high voltage and high current sources. Always remove line power from the power supply when servicing and only allow qualified personnel to maintain this power supply.

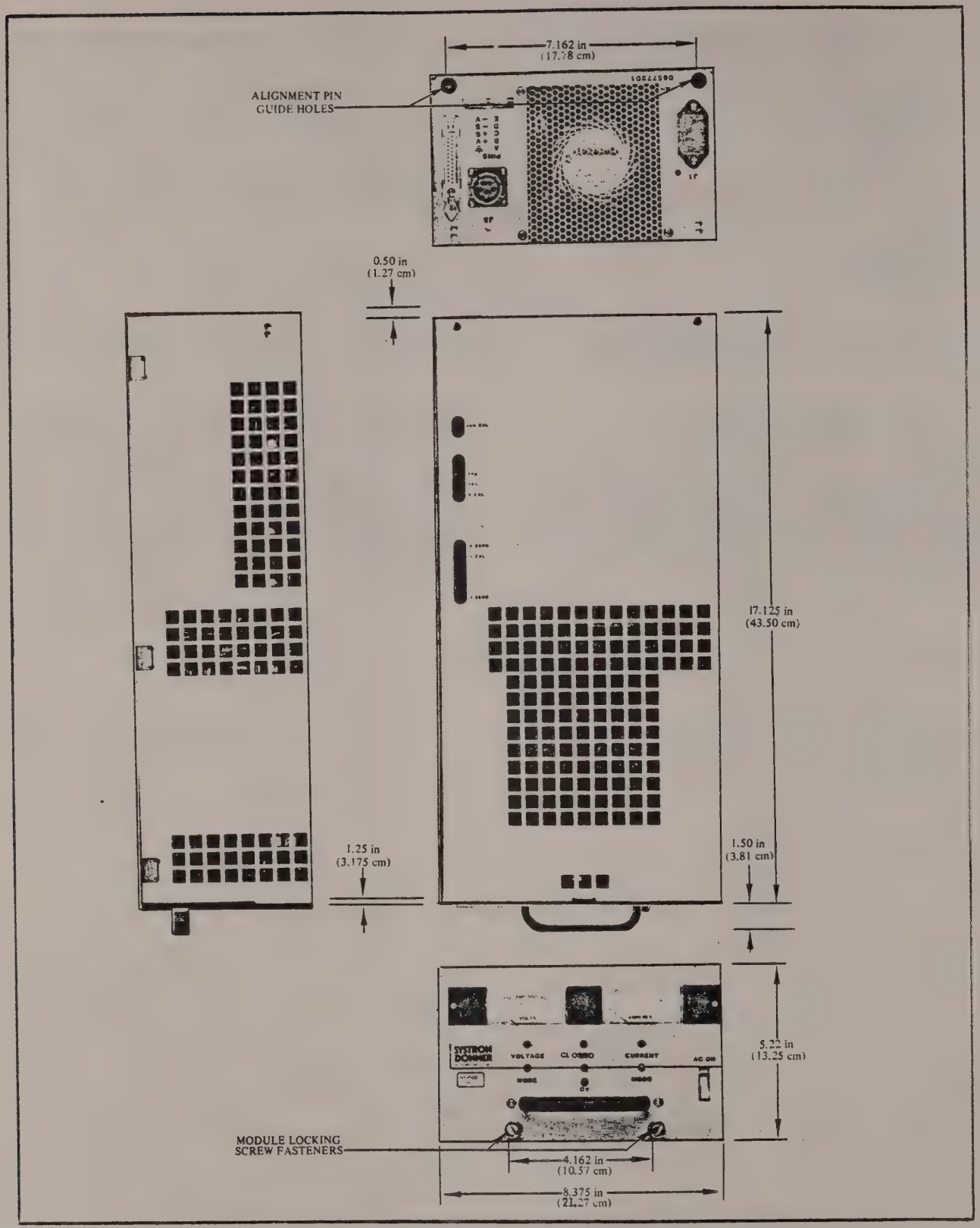


Figure 1-1. HFP500-1 Power Supply Outline Drawing

CHAPTER 2

INSTALLATION AND OPERATION

2-1. INTRODUCTION

2-2. This chapter outlines the procedures for initial inspection, installation and operation of the HFP500-1 Power supplies. Instructions concerning preparation for reshipment are also included should the power supply be returned to Systron Donner for service or repair.

2-3. RECEIVING INSPECTION

2-4. Prior to accepting the power supply from the shipper, inspect the condition of the shipping container for any indication of freight damage. Any sign of such damage must be noted by both the shipper and receiver and should be reported to the insurance investigator.

2-5. Immediately following removal of the power supply from the shipping carton, inspect for possible physical damage incurred during shipment. Check external surfaces for scratches or dents and note the condition of all connectors, circuit breakers, etc. that protrude from the front and rear panels of the rack assemblies. Should any damage be detected, notify your nearest Systron Donner representative - DO NOT USE THE INSTRUMENT UNTIL INSTRUCTED TO DO SO BY THE REPRESENTATIVE.

2-6. PREPARATION FOR RESHIPMENT

2-7. When the Power Supply is repackaged for shipment, use original packing materials or package in accordance with MIL-P-116 and MIL-3-17555E specifications. Repackage the instrument using the following step procedures:

1. Attach an identification tag to the system indicating model and serial number, name and address of instrument owner, and a summary of the service or repairs required.
2. Wrap the assemblies in sheets of heavy paper or plastic prior to placing it in the shipping container.
3. Select a strong carton or wooden box as a shipping container.
4. Use an adequate layer of shock absorbing material on all six sides of the unit. Protect the instrument front panel and panels with additional layers of cardboard. Ensure that no movement of the assembly is evident within the container.
5. Seal shipping container with strong tape or metal bands. Attach a packing list to the outside surface.
6. Mark shipping container "FRAGILE-DELICATE INSTRUMENT" and attach the appropriate handling symbols to ensure reasonable care in transit.
7. Be certain all correspondence relating to service or repair of the system includes information contained on the power supply identification tag.

2-8. INSTALLATION

2-9. The HFP500-1 Power Supply is designed to mount into the Systron Donner RA4 rack assemblies. Two power supplies may be installed into a RA4 rack assembly. Rear panel shear alignment pins, guide holes and front panel captive module locking fasteners, provide for the installation of the module into the RA4 Rack Assembly.

2-10. The RA4 Rack Assembly requires a rack space envelope of 5.22 in (13.25

cm) high, 16.97 in (43.10 cm) wide and 22 in (55.88 cm) deep; 3 in (7.62 cm) of the depth requirement is for rear panel protrusion and clearance of cables and connectors. The RA4 rack assembly is provided with provisions for installation of rack mounting slides. Refer to the related programmable power supply system manual for detailed system installation requirements.

2-11. OPERATING ENVIRONMENT

2-12. The HFP500-1 Power Supply is designed to meet the following environmental requirements:

Operating temperature:	0 to +50°C.
Non-operating temperature:	-40 to +65°C.
Humidity:	5 to 85% relative, non-condensing.

2-13. POWER REQUIREMENTS

2-14. The HFP500-1 Power Supply requires 115/230 V ac ±10% 47 to 63 Hz line power. Power consumption is 800 watts maximum. Heavy duty 3 wire detachable line cord with molded NEMA type 5-15P plug provides for the input power connection via rear panel IEC type connector J1.

2-15. The power supply is shipped from the factory normally wired for 115 volts unless it was ordered with a 230 volt system or requested by the customer that 230 V operation be provided. Prior to operation ensure that the power supply is wired for the correct line voltage application. To reconfigure input line voltage rewire the primary windings of transformers T1 and T2 in accordance with table 2-1 and figures 6-1 and 6-2 located in chapter 6 of this manual.

Table 2-1. Power Transformer Primary Connections

Line Voltage	Primary Winding Connections
115 V	1 to 3 and 2 to 5
230 V	2 to 3

WARNING

Before applying power, ensure that the protective ground terminals of the power supply module is connected to the protective conductor of the (mains) power cord. The cord plug shall only be inserted into an outlet provided with protective ground contact. The protective conductor must not be negated by the use of an extension cord without a protective grounding conductor.

2-16. The power supply is provided with a front panel 10 A circuit breaker CB1 which provides overload protection and facilitates the application and removal of the line power.

2-17. The power handling ability of the ac mains feeding the ac power to the line cords must be considered as serious losses in regulation and substantial increase in ripple can occur as a consequence of insufficient power handling capacity of these mains. The impedance from the breaker box to the power supply input receptacle should not exceed 0.25 ohms. All ac feed line connections must be securely tightened and any moveable electric contact surface (such as the wiper arm of a variable transformer) should be kept clean of impedance producing oxide coatings.

2-18. OUTPUT CONNECTIONS

2-19. The output of the power supply to the UUT load is provided for by a rear panel 5-pin circular twist lock connector J3, ITT Cannon KPT0014-5S or equivalent SD part number 117696. The required mating connector (not supplied), is ITT Cannon KPT06B-14-5P or equivalent. Table 2-2 provides the pin designations for the output connector J3.

Table 2-2. Output Connectors Pin Designations

Pin	Function
A	Ground
B	+ V Output
C	+ Sense
D	- Sense
E	- V Output

2-20. The + V output and + sense and - V output and - sense connector pins may be jumpered to allow local sensing, or sense leads can be connected to the UUT load to allow remote sensing, noting however, that a voltage drop of 0.5 V per power lead must not be exceeded.

NOTE

If sense leads are not connected to the UUT or the connector +V and -V output pins, the power supply regulation cannot be maintained. The power supply outputs must be configured for either local or remote sensing. However, built-in circuitry is provided to protect the power supplies from damage should a sense lead or jumper open.

2-21. When interfacing the power supplies output with the UUT loads, ascertain if local or remote sensing is to be used. If local sensing is used, ensure that pins B and C and D and E are jumpered at the mating connector. If remote sensing is used connect sense leads between the + sense (pin C) and - sense (pin D) of the mating connector and the UUT load. If long sensing leads are required, they should be a shielded twisted pair, with the shield grounded at the power supply mating connector pin A and the load end left open.

2-22. Ensure that the power leads connecting the + V and - V output of the power supply to the UUT load is of sufficient gage to carry the maximum current rating of the power supply outputs (a minimum of 500 circular mils per ampere is recommended).

2-23. To determine the proper wire size (AWG) for load leads, a nomograph (figure 2-1) is provided. The wire size is determined by two factors: maximum current carrying capacity recommended for any AWG (500 circular mils per ampere) and maximum tolerable voltage drop across a load lead (0.5 V per lead).

2-24. To find maximum current capacity for standard wire size (AWG), lay a straight edge from the AWG on scale 2 to point A on scale 3, then read the maximum current off scale 1. To find the voltage drop in mV/ft for a known wire size and operating current, lay a straight edge from the operating current on scale 1 to the AWG on scale 2. Then read the voltage drop on scale 3. To find the wire size required for a known operating current and the maximum tolerable voltage drop across the supply leads, first ascertain the maximum tolerable IR drop in mV/ft of lead (sum of the positive and negative leads). Then lay a straight edge from this value on scale 3 to the known maximum operating current on scale 1 and read the wire size in AWG on scale 2.

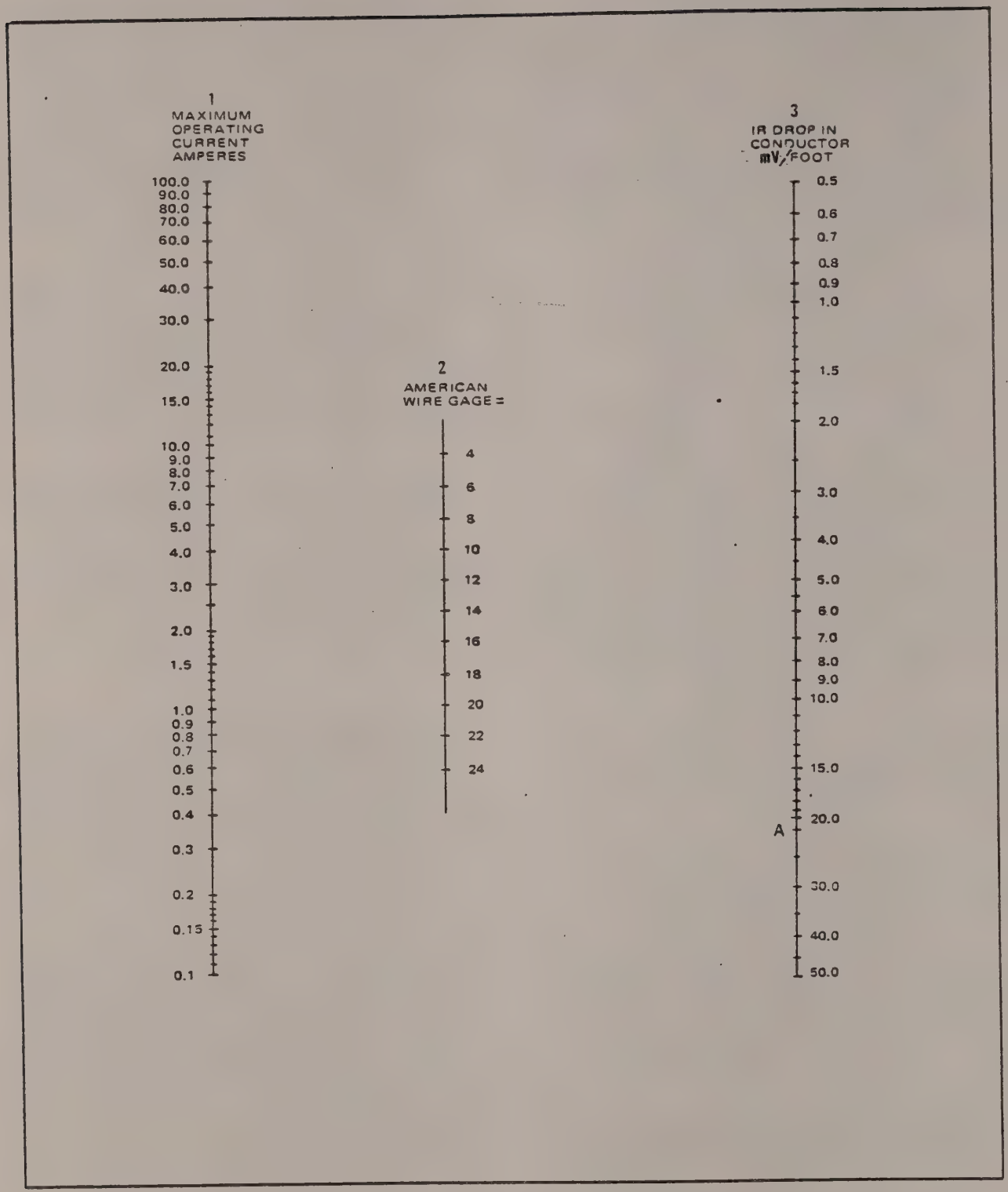


Figure 2-1. Load Lead Wire Size Nomograph

2-25. FRONT PANEL

2-26. The meters, indicators, circuit breaker and other features located on the front panel of the Power Supply are described in table 2-3. Figure 2-2 depicts these functions by index number.

Table 2-3.
Front Panel Functions

Index	Name	Function
1	AC ON	A 10 A circuit breaker, provides overload protection and facilitates the application and removal of the line power.
2	VOLTS	A voltmeter, that indicates the output voltage of the power supply.
3	AMPERES	An ammeter, that indicates the current being supplied to the UUT load by the power supply.
4	CLOSED	An amber LED indicator, illuminates when the output relay is closed, indicating that the output of the power supply is being applied to rear panel output connector J3.
5	VOLTAGE MODE	A green LED indicator, illuminates when the power supply is operating in the voltage stabilization mode.
6	CURRENT MODE	An amber LED indicator, illuminates when the power supply is operating in the current stabilization mode.

Table 2-3.
Front Panel Functions (Cont'd)

Index	Name	Function
7	OV	A red LED indicator illuminates when the power supply is in the voltage limit (V_{LIM}) mode.
8		Two captive module locking fasteners, secures the power supply module into the RA4 rack assembly. Rotate ccw to disengage and cw to engage.

2-27. REAR PANEL

2-28. The connectors and other rear panel features are described in table 2-4. Figure 2-3 depicts their location by index number. Table 2-2 provides the pin designations for output connector J3. Pin designations for the programming connector J2 are provided in table 2-5.

Table 2-4.
Rear Panel Functions

Index	Name	Function
1	J1	An IEC type power receptical, provided for the connection of line power.
2	J2	A 25-pin connector which provided interface with the P6/P12 Programmer. Refer to table 2-5 for the pin designations of this programming connector.

Table 2-4.
Rear Panel Functions (Cont'd)

Index	Name	Function
3	J3	A 5-pin circular twist lock connector, provides for the interface with the UUT load. Refer to table 2-2 for the pin designations of this output connector.
4		Two-shear alignment pin guide holes, provide the proper alignment of the power supply module when being inserted into the RA4 rack assembly.
5		Air Exhaust (Fan), removes heat from the internal heat sink. DO NOT OBSTRUCT AIR FLOW THROUGH THIS PORT.

Table 2-5. J2 Programming Connector Pin Designations

Pin	Function
1 thru 4	Signal common referenced to +V of the power supply.
5	+15 V referenced +V
6	Not Used
7	Not Used
8	Not Used
9	Not Used
10	Voltage Mode Flag.
11	Current Mode Flag
12	Overvoltage (V_{LIM}) Flag
13	Not Used
14	Voltage Control Input (0 to +10 V)
15	Normalized -V Output (0 to -10 V)
16	Current Control Input (0 to +10 V)
17	Not Used
18	Voltage Limit (V_{LIM}) Control Input (0 to +10 V)
19	Output Enable (+5 V)
20	Close Output Relay (CLOSE Command)
21	Polarity Reverse (REV command)
22	Not Used
23	Flag Common (+5 V Logic return)
24	Over Temperature Flag
25	Output Relay Closed Flag

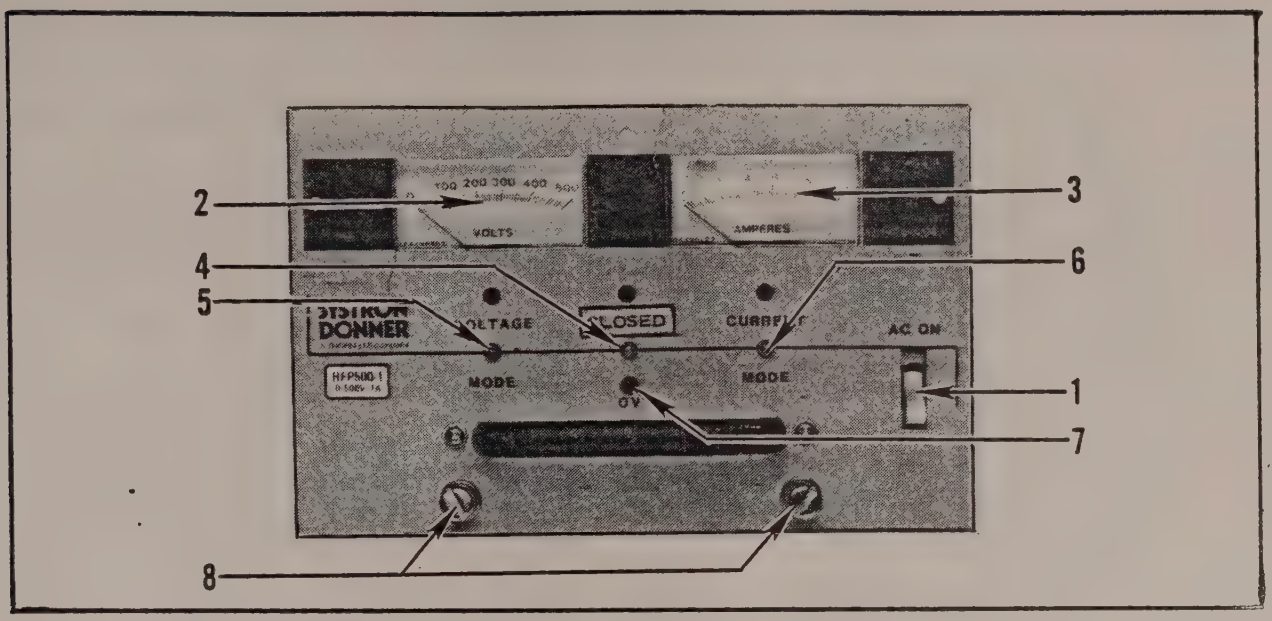


Figure 2-2. HFP500-1 Front Panel Functions

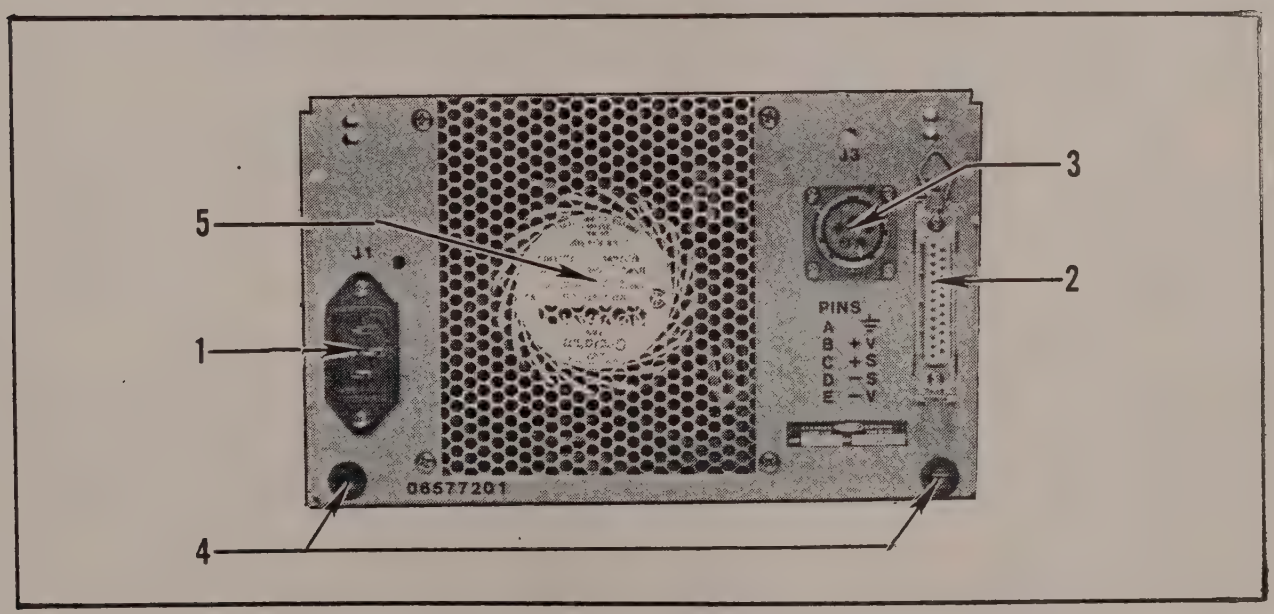


Figure 2-3. HFP500-1 Rear Panel Functions

CHAPTER 3

PRINCIPLES OF OPERATION

3-1. INTRODUCTION

3-2. The following functional description is referenced to the HFP500-1 schematic diagrams located in chapter 6 of this manual.

3-3. FUNCTIONAL DESCRIPTION

3-4. The overall function of the power supply is to transform and rectify the ac input line voltage into a well regulated, stable and adjustable dc output. In performing these functions, the circuitry can be divided into the following subfunctions.

1. Main Power Circuit
2. Auxilary Power Circuit
3. Voltage Stabilization and Control
4. Current Stabilization and Control
5. Voltage Limit (V_{LIM}) Circuits
6. Shut-down Circuits
7. Output Relay Functions

3-5. MAIN POWER CIRCUIT

3-6. All power for the supply is fed through the detachable line cord to the rear panel connector J1. Front panel mounted circuit breaker CB1 provides protection from overload fault conditions and for the application and removal of line power.

3-7. The main power circuit rectifiers consists of pcb assemblies A2 and A4, each containing diodes and filter capacitors for two full wave rectifiers, one positive and one negative. The four rectifiers are connected in series to provide an output of 600 V nominal with taps at 150 V, 300 V and 450 V. Each tap is connected via a source blocking diode to the common drain connection of each rank of quad pass transistors. Resistors A2R1, A2R2, A4R1 and A4R2 function as bleeders to discharge the filter capacitors when power is removed.

WARNING

Under worst case conditions of high line voltage, no load and maximum RC time, it could take 32 seconds to discharge the capacitors to a non-hazardous potential of less than 42 volts. Always wait at least one minute after power is removed or use a shorting bar before attempting to service the power supply.

3-8. The sixteen series pass transistors comprise an array of four ranks in series, with each rank consisting of four field effect transistors (FETs) in parallel. The lowest rank consisting of FETs Q13 through Q16 functions as the "regulator" of the series pass circuitry and is controlled by the voltage control amplifier A1U1 via emitter follower A1Q1 located on the Control PCB Assembly. The higher FET ranks, act as a "pre-regulator" and serves to control the pass voltage across the lowest FET rank when the output is greater than 150 V nominal. Their gates are biased by adjustable voltage regulator A1U10 which is adjusted by potentiometer A1R55 to provide a voltage of 16.3 V above the output of the lowest FET rank. FETs are somewhat analogous to bipolar NPN power transistors, where the drain is the collector, the gate is the base and the source is the emitter. The main difference is that FETs are voltage controlled instead of being current controlled and the gate to source voltage at which they start to conduct is approximately +3.5 V, being much higher than the diode drop of a bipolar transistor. Because they are used in the linear mode (not as

saturated switches), the paralleled FETs will not self regulate to share their current equally. Because of production variations their gate to source voltage for a given drain current may vary up to 20% from a nominal (3.5 V). Therefore it is necessary to insert the 10 ohm degeneration resistors in series with their sources. These degeneration resistors produce current sharing at one ampere to be within approximately 30 mA of the nominal 250 mA for each FET.

3-9. A simplified schematic of the series pass circuitry is provided for by figure 3-1, where the parallel elements have been combined and the four power sources are shown as series batteries. The following description of the series pass circuitry is referenced to figure 3-1. Assuming a one ampere load current, at zero output volts, all the current will be from the lowest ranked source (battery), via diode A4CR5, the regulating FETs Q13 through Q16, source resistors R17 through R20, to the load and back to the negative battery return. The drain to source voltage (V_{DS}) of Q13 through Q16 is 146.7 V and the regulator FETs are dissipating 146.7 W. The higher rank FETs are not conducting because their gate diodes CR6, CR7 and CR8 are back biased. This current path is the same for outputs up to 137 V. At 137 V output the V_{DS} of Q13 through Q16 has dropped to 9.7 V and FETs dissipation is 9.7 W with 2.5 W being dissipated in resistors R17 through R20 and the balance of the power going into the load. However, due to the 16.3 V from A1U10, diode CR8 is now foward biased and the gate to source voltage (V_{GS}) of the second rank of FETs Q9 through Q12 has reached +3.5 V. By the time the output voltage reaches 139.5 V the second rank FETs are carring all of the current (1 ampere) and diode A4CR5 stops conducting and becomes back biased. The V_{DS} of Q13 through Q16 is now fixed at 7.2 V, and all current flows from the lower two sources via diode A4CR6; the higher two ranks are still biased off. The second FET rank is now dissipating most of the internal power, 147.5 W, while the first FET rank is dissipating only 7.2 W. As the output voltage is increased still further, more power goes to the load and less is dissipated in the second rank FETs.

3-10. When the output voltage is increased to 287 volts, the third rank of FETs starts to conduct and by an output level of 289.5 V it is supplying all the current and diode A4CR6 becomes back biased. At this point the third FET rank is dissipating 147.5 W and the second FET rank only 0.4 W and the first FET rank 4.3 W. And again as the output voltage is increased more power goes into the load and less is dissipated in the third FET rank.

3-11. Finally as the output voltage reaches 437 Volts the fourth FET rank starts conducting and at 439.5 V output level it is supplying all the current and diode A2CR5 becomes back biased. The fourth rank is now dissipating 148.3 W, the second and third ranks 0.4 W each and the first rank about 1.4 W. At the maximum voltage output of 500 V, dissipation in the highest rank will decrease 60.5 W to about 88 W.

3-12. The foregoing included some assumptions to simplify the discussion. At low line voltage (-10%) the raw voltages of the sources would be lower and hence the crossover points would be lower. The converse would be true at high line voltage. Ripple on the raw supply sources will broaden the crossover from one FET rank to the next. The required gate voltage also changes somewhat between the start of conduction and full current level of one ampere. Thus, measured values may not agree exactly with the values stated in the discussion, but the principals remain the same. The upper FET ranks supply operating voltage to the lowest or regulating FET rank on an as required basis for outputs above approximately 25% full scale. The effect is to limit dissipation in the FETs to about 150 W under all load conditions. If preregulation were not used, the dissipation would be 600 W at zero volts

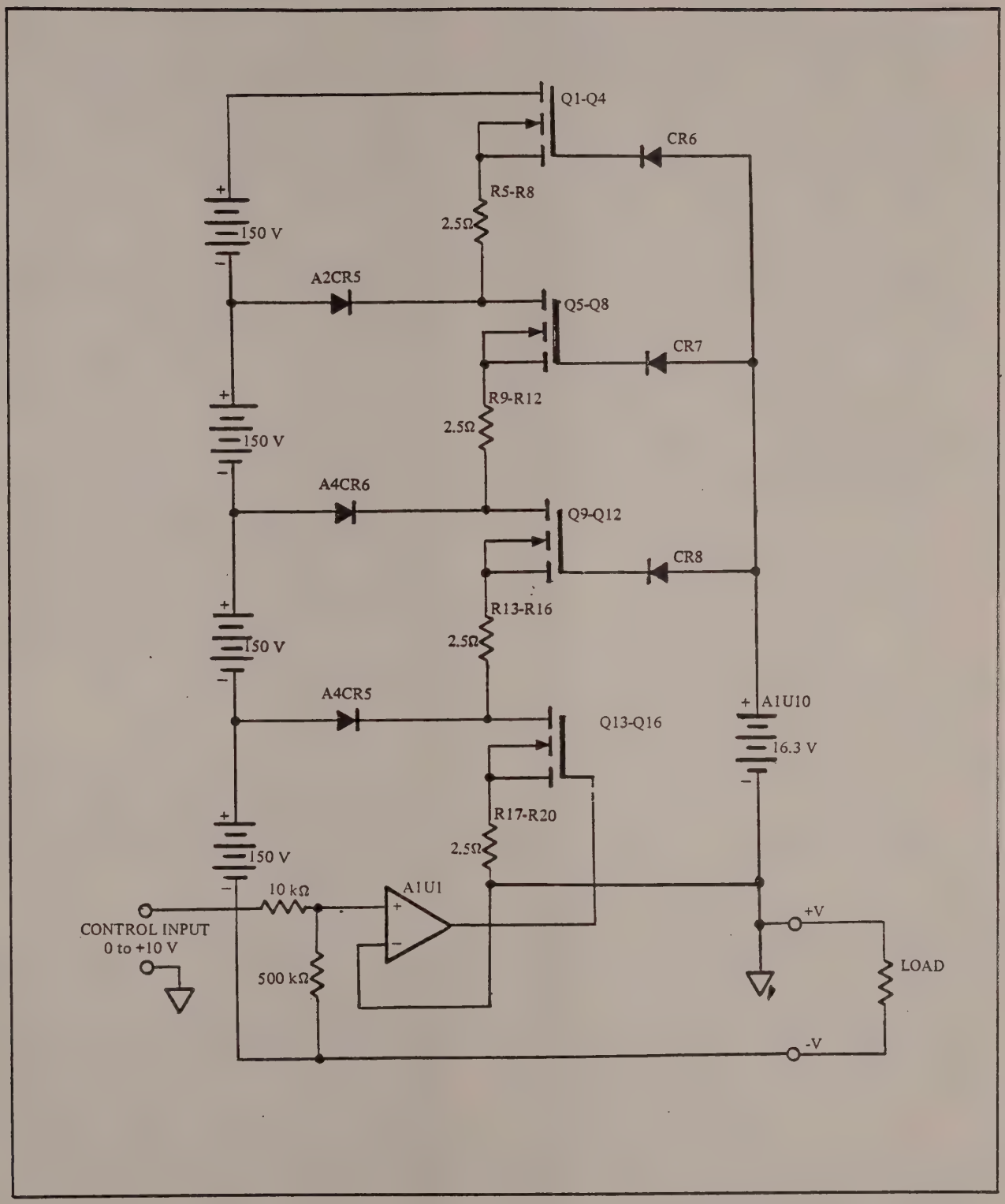


Figure 3-1. Series Pass Circuitry Simplified Schematic Diagram

with a one ampere output. Hence efficiency at high current and medium to low output voltage is greatly improved by preregulation. The series arrangement also ensures that the FET drain to source voltage will never exceed 185 V, thus allowing the use of 350 V FETs with ample derating.

3-13. AUXILIARY POWER CIRCUIT

3-14. Additional fixed voltages are required to operate the control circuitry of the power supply. This is obtained from T1 secondary taps 13-14-15 which is applied to the A1 Control PCB Assembly auxiliary rectifier A1CR1. Bridge rectifier A1CR1 and filter capacitor A1C1 and A1C2 supply raw +22 V to A1U7, a +15 V IC voltage regulator and raw -22 V to A1U8 and A1U9 which are -6 V and -15 V IC voltage regulators.

NOTE

The auxiliary power supply voltages are referenced to the A1 Control PCB Assembly power common which is symbolized as (⏃) on the schematic diagrams.

3-15. VOLTAGE STABILIZATION AND CONTROL

3-16. In the voltage stabilization mode, the output voltage of the power supply is controlled by the combination of voltage control amplifier A1U1, emitter follower A1Q1, sense amplifier A1U4 and the heat sink mounted series pass transistors Q1 through Q16. They form the major part of a closed loop, negative feedback control system. The output stage (pass transistors) function as an inverter when measuring from +V, thus A1U1 input pin 3 is actually the inverting input. Pin 2 is then the noninverting or reference input and is connected to +V via A1R5.

NOTE

On the schematic +V is indicated by an inverted triangle symbol (⏚), which is the signal common reference for the control functions.

3-17. The input resistance to A1U1 pin 3 is the series combination of A1R1, A1R2 and A1R3. It is adjusted by potentiometer A1R1 (V CAL) to a nominal 10 kΩ. The input voltage from zero to +10 V is referenced to +V (⏚) and is supplied by the DAC-4 Assembly in the P6/P12 Programmer. The feedback resistor A1R4 receives the $-V_n$ (normalized -V) signal from the sense feedback amplifier A1U4. The ratio of power supply output voltage to the programming voltage is determined by the values of A1R26, through A1R33. The V_n CAL potentiometer A1R28 provides for the setting of this output voltage to programming voltage ratio, thus, summing junction pin 3 of A1U1 is thus held at the same potential as pin 2 i.e., +V (⏚).

3-18. CURRENT SINK CIRCUIT

3-19. The current sink (pulldown) circuit provides for the discharge of the power supply output capacitor C5 and any external capacitance related to the load during dynamic down programming of the power supply.

3-20. The output of A1U1 pin 6 is normally at +3.5 V to +4 V and A1Q2 is thus biased off. However during down programming, A1U6 pin 6 will go negative until the output of the power supply drops to its programmed lower value. This negative potential turns on A1Q2 via A1CR4 and A1R17. Transistor A1Q2 is current limited to about 15 mA by resistor A1R19, and diodes A1CR12 and A1CR13. This A1Q2 current turns on optical isolator A5U1. The circuitry on the output side of isolator A5U1 is referenced to -V. When

A5U1 is turned on it shunts the current from -V +150 at A4 pin 6 via A5R45 directly to -V. This effects the turn off of transistor A5Q19 by removing its base drive. Current from the +15 V auxiliary supply at A1 pin 13 via A5R46 and A5R47 must now flow through Zener diode A5R14, which sets 5.6 V on the gate of FET A5Q18. FET A5Q18 turns on and as its drain voltage drops FET A5Q19 also turns on. Voltage divider consisting of A5R46 and A5R47 maintains the junction of the FETs via diode A5CR9 at approximately mid-point between +V and -V, thus dividing the output voltage and power equally between the two FETs. Ten ohm resistor A5R43 limits the pulldown current to a maximum of 0.2 A. At 0.2 A A5R43 drops 2 V, which is added to the 3.6 V gate drive required by FET A5Q18 which provides a sum of 5.6 V (which equals the bias voltage from A5CR14). Any increase in current flow (greater than 0.2 A) will bias A5Q18 to limit the current. At 0.2 A pull-down time required to dischage the 1 μF output capacitor C5 from 500 V to zero volts is approximately 2.5 ms.

3-21. CURRENT STABILIZATION AND CONTROL

3-22. The current stabilization and control function will sharply limit the amount of current which can be delivered to the load. The current supplied is obviously a function of the load impedance: no load no current; short circuit maximum programmed current. The crossover from constant voltage to constant current stabilization mode is automatic. The point at which the stabilization mode switches over is a function of the load and occurs at a critical value of the load resistance R_C = Ep/Ip, where Ep is the programmed voltage value and Ip is the programmed current value.

3-23. Current control is provided by operational amplifier A1U3. A sampling of the output current is provided by the voltage drop across the current measuring shunt A1R11. the input side of the shunt is connected to A1U3 pin 2 via A1R16 as a reference level. The other input pin 3 is the summing junction and is connected to the negative feedback current from A1R12 (I CAL) potentiometer and resistor A1R13 and the current control 0 to 10 V programming level from the DAC-4 PCB Assembly in the P6/P12 Programmer. When in the current stabilization mode, these two currents are equal and opposite so that the potential on pins 2 and 3 are equal. The shunt A1R11 value of 0.1 ohm is chosen so that a full rated output current of 1 A will develope a corresponding -1 mA. Thus, the current control input current is from 0 to +1 mA.

3-24. The output of the operational amplifier A1U3 pin 6 is connected through Zener A1R32 and isolating diode A1CR14 to pin 8 of A1U1. Pin 8 serves as an auxiliary input to the voltage amplifier and will control its output at pin 6. When operating in the current mode the input to A1U3 pin 2 is only slightly negative so that the output at pin 6 goes low enough to control the loop.

3-25. When the power supply is not in the current mode, isolation diode A1CR14 is back biased and the current amplifier A1U3 has no effect on the power supply operation. A1U3 pin 6 is also connected to inverter A1U11-6, which feeds inverter drivers A1U12-6 and A1U12-2 in tandem. Inverter driver A1U12-6 connects to optical isolator A1U6 pin 3 which will illuminate the power supplies front panel CURRENT MODE LED DS3 and generate an isolated current flag at A1J1 pin 14 when the current amplifier A1U3 has control of the loop. Inverter driver A1U12-2 connects to optical isolator A1U5 pin 3 which will illuminate the front panel VOLTAGE MODE LED DS1 and generate an isolated voltage mode flag at connector A1J1 pin 15 when not in the current mode.

3-26. VOLTAGE LIMIT CIRCUITRY

3-27. Operational amplifier A1U2B is the voltage limit (V_{LIM}) control amplifier. The reference input pin 6 is con-

nected to +V through A1R40. Pin 5 is the summing junction: the feedback resistor is A1R37 and valued at 11.00 Ω. The programmed voltage applied to the V_{LIM} input at A1R36 (valued at 10.00 kΩ) is normlly higher than the voltage programming input to A1U1 pin S. Thus, the output voltage of the power supply is normally below the V_{LIM} set point. Under these conditions the positive input current to A1U2B is greater than the feed back current. The excess from the summing junction flows through diode A1CR23 to +V. The net effect is a positive potential being placed on A1U2B pin 5, which drives the output A1U5 pin 7 positive. On this positive potential isolating diode A1CR16 conducts and allows A1U2B to control the output of A1U1 instead of the voltage control programming input at A1U1 pin 3. Any further increase in the voltage programming input at A1U1 pin 3 will have no effect, because the power supply output is clamped and controlled at the V_{LIM} setpoint by A1U2B.

3-28. A1U2B output at pin 7 is also connected to inverter A1U11-4 which feeds inverter driver A1U12-4. Inverter driver A1U12-4 connects to optical isolator A1U5 pin 2 which will illuminate the power supplies front panel OV LED DS4 and generate an isolated over voltage flag at A1J1 pin 13 when the V_{LIM} amplifier A1U2B is controlling the unit.

3-29. POWER SUPPLY SHUT-DOWN FUNCTION

3-30. Amplifier A1U13 provides for the shut-down of the power supply via diode A1CR17 to pin 8 of A1U1, when a SD gate from the Relay Assembly A3 is generated on a power supply open/close operation. The power supply will also shut-down when the Heat Sink Assembly exceeds a temperature of 70°C causing the over-temperature switch A5S1 to close. When switch A5S1 closes, a low is also placed on optical isolator A1U6 pin 2 which generates an isolated overtemp flag at connector A1J1 pin 11.

3-31. OUTPUT RELAY FUNCTIONS

3-32. Relay Assembly A3, provides the logic and relay switching for the output relay open/close operation. Raw +22 V from the auxiliary rectifier A1CR1 is applied to A3J2 edge connector pin 10 to provide relay solenoid voltage and input to the +5 V on board voltage regulator A3U1. Exclusive NOR gate A3U2-3 function as a state change detector and will generate a low at A3U2 pin 3 when the CLS command at connector A3J2 pin 8 changes state. Dual one-shot multivibrator A3U3A/B will trigger on a negative edge. One-shot A3U3A will generate a 10 ms duration gate at pin 13 on the detection of an open/close operation command, which is inverted by A3U2-4 to generate the SD1 output at A3J2 pin 2. This SD1 (shut-down) signal is applied to the Control PCB Assembly A1, which will shut-down the power supply for a 10 ms period to allow for the opening and/or closing of the output relay A3KV1. Oneshot A3U3B generates a 5 ms delay. At the end of this 5 ms delay period A3U3B pin 12 goes high and sets D type flip-flop A3U4 to whatever the input command is: open or close. This 5 ms delay allows all relay switching to be centered time-wise on the 10 ms shut-down period when the power supply is at zero volts output. The output of D type flip-flop at A3U4 pin 5 is inverted by gate A3U2-10 and applied to driver transistor A3Q1 which will effect the opening or closing of the sense lines by relay A3KS. Flip-flop A3U4 pin 5 output is also applied to gate A3U2-11 for inversion and drive via transistor A3Q2 to open or close relays KV1 and KV2. Relay A3KV1 is the output relay and provides for the opening and closing of the +V and -V lines. Relay A3KV2 provides a CLSD signal as a ground return when the output of the power supply is closed which is applied to the Control PCB connector A1J2 pin 10 to feedback a CLOSE flag to the P6/P12 Programmer via rear panel connector J2 pin 20.

CHAPTER 4

MAINTENANCE

4-1. INTRODUCTION

4-2. This chapter contains the procedures for preventative maintenance, corrective maintenance, performance tests and calibration of the HFP500-1 Power Supply.

4-3. PREVENTATIVE MAINTENANCE

4-4. Preventative maintenance consists primarily of cleaning and visual inspection. When performed on schedule, preventive maintenance will prevent possible power supply breakdown and improve the reliability of the power supply. Severity of environment, to which the power supply is subjected, will determine the frequency of the periodical maintenance schedule. A convienient time to perform preventive maintenance schedule is just before recalibration.

4-5. Cleaning

4-6. The power supply cover provides protection against dust in its interior. Operation with cover removed will necessitate more frequency cleaning, and will effect the performance of the power supply by upsetting its interior thermal balance and making it more susceptical to electromagnetic interference (EMI).

4-7. Interior Cleaning

4-8. Dust on the interior of the power supply must be removed due to its electrical conductivity when high-humidity is present. Dust can also cause overheating and component breakdown. Dust or dirt on components surfaces acts a a thermal insulating blanket and thus prevents heat sinking, which can lead to component failure. The recommended way to remove accumulated dust is to blow it off with dry oil-free low pressure air (approximately 10 lbs/in^2). Any dirt that remains should be removed with a soft brush or lint free cloth dampened with a proper cleaning agent. A cotton-tipped applicator ("Q-tip") should be used to clean in narrow spaces or around components on the printed circuit boards

CAUTION

Certain components within the power supply can be damaged by use of carbon-based solvents. Avoid use of chemicals that contain acetone, benzene, tuluene, xylene, petroleum ether, kerosene, carbon tetrochloride, methylene, chloride, and trichlorotrifluoroethane (i.e., freon 113, -tf-tatme). Recommended agents for interior cleaning are isopropyl alcohol or kelite (1 part kelite to 30 parts water). It is safe to use ethyl alcohol and methyle alcohol if the recommended solvents are not available.

4-9. Exterior Cleaning

4-10. Dirt accumulated on the exterior of the power supply may be removed with a soft cloth or a small paint brush damp ened with a mild detergent and water solution. Abrasive cleanser should never be used.

4-11. Lubrication

4-12. All adjustment potentiometers use in the power supply were installed with proper lubrication where necessary and will rearly require any additional lubri-

cation. Thus it is recommended that a regular periodic lubrication program not be performed on the power supply. If the power supply is rack mounted using slide assemblies, periodic lubrication of the slide assemblies is recommended using a high temperature grease such as "Lubriplate".

4-13. Visual Inspection

4-14. Visually inspect the power supplies mechanical integrity for such items as loose plug-in pcb assemblies, loose or detached cable assemblies, etc. Then check the chassis, pcb assemblies, and modules for mechanical and thermal damage, i.e.; broken, bent, discolored or charred components parts.

4-15. The corrective procedure for most of the visible defects is obvious; however, particular care must be taken if thermal damage is noted. Overheating usully indicates other trouble in the module; therefore, it is important that the cause of overheating be corrected to prevent possible recurrence of thermal damage to the replaced component.

4-16. TEST AND CALIBRATION

4-17. Test Configuration

4-18. Figure 4-1 depicts the test configuration for the HFP500-1 power supply. The output mating connector should be configured with the appropriate wiring to connect the test configuration.

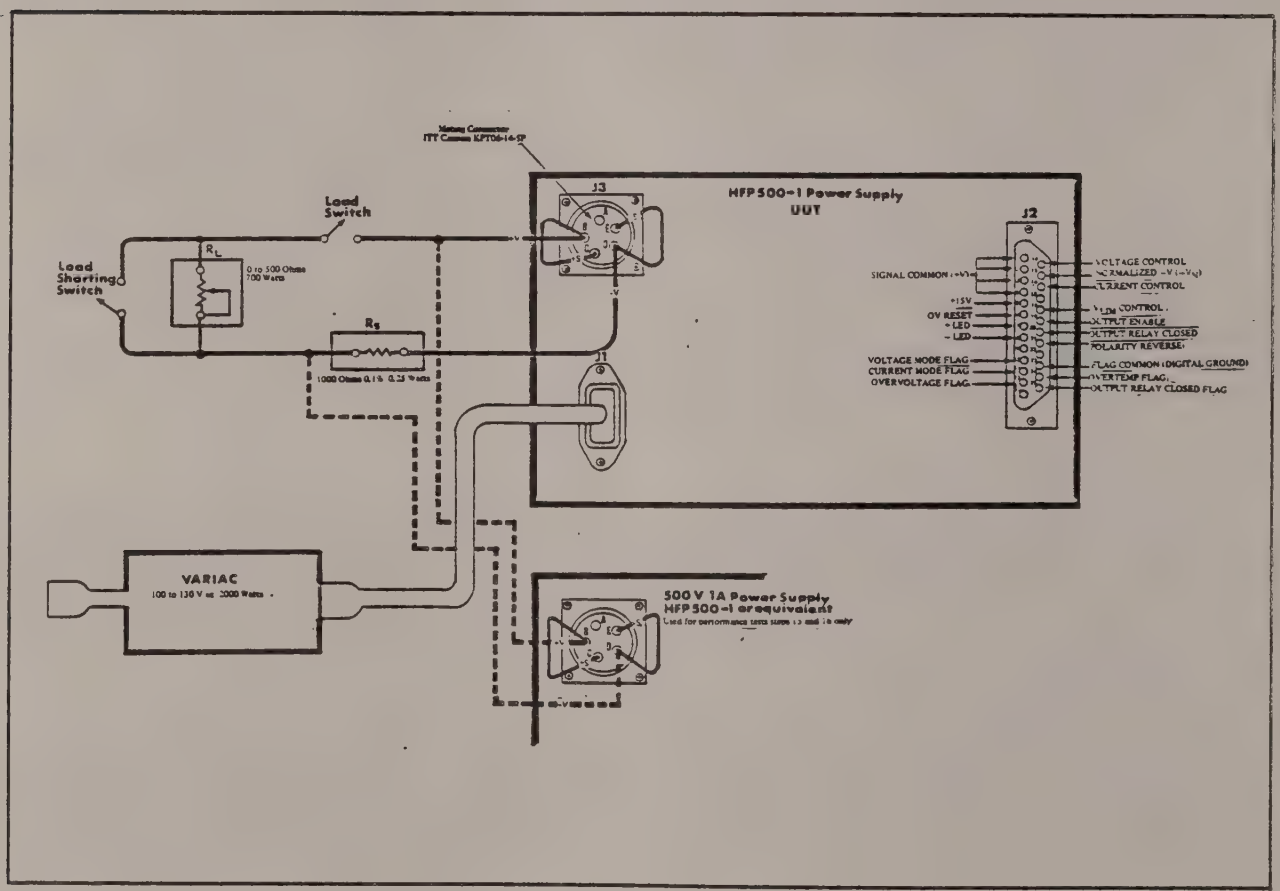


Figure 4-1. HFP500-1 Test Configuration

NOTE

The test configuration wiring and switches must be capable of handling one ampere of current.

WARNING

Performance of the following procedures exposes the technican to possible contact with 600 volts. Use caution and follow the procedures exactly as written.

NOTE

The following procedures require that the UUT be wired for 115 V ac nominal line power, as it is nornally shipped from the factory. Prior to performing procedure, ensure that the UUT is configured for 115 V ac operation.

NOTE

The adjustment potentiometers located on the A1 Control PCB Assembly can be access through cutouts on the top cover. If adjustments on the Meter Option PCB Assembly or adjustment of A1R55 are to be performed, the top cover will have to be removed to provide access to the adjustment potentiometers.

WARNING

Before appling power to any unit of the test configuration, ensure that the protective ground terminals of the UUT and the test equipment are connected to the protective conductors of the (mains) power cords. The power cords plugs shall only be inserted into outlets provided with protective ground contacts.

4-19. Test Equipment

4-20. Table 4-1 lists the test equipment required to test and calibrate the HFP500-1. Alternate test equipment with equivalent characteristics may be used when the recommended types are not available.

Table 4-1.
Recommended Test Equipment

Variable Autotransformer (Variac)	100-130 V 2000 watts
RMS Voltmeter Hewlett Packard Model 400D	100 µV sensitivity
Digital Multimeter Datron Model 1071	6-1/2 digit 0.01%
Digital Multimeter Fluke Model 8810A	5-1/2 digit 0.01%
Shunt Resistor	1000 ohms 0.1% 0.25 watt.

Table 4-1.
Recommended Test Equipment (Cont'd)

Programming Source Systron Donner P6/P12 with DAC-4 pcb installed, with a controller device capable of communicating in MATE CIIL language commands via an IEEE-488 GPIB interface	Three precise independent floating outputs into 10 kΩ loads over a range of 0.0000 to 10.000 V dc, open/close relay command, reset command (momentary), means for displaying flags from the power supply under test and interface cable/ connector to power supply under test connector J2.
Appropriate Load Resistors, Rheosate or Load Bank	0 to 500 ohms 700 watts minimum.
Power Supply Systron Donner HFP500-1 with P6/P12 Programmer	500 V, 1 A precision, adjustable, floating current limited.
Output interface mating connector with appropriate load and sense wiring	ITT Connon PT06-14-5P

4-21. Calibration Procedure

NOTE

The following procedure utilizes a precision voltage source as programming device. If the P6/P12 Programmer is available the appropriate stimulus may be generated and applied by the P6/P12, to a resolution of 0.025% using command entry procedures. Refer to the systems manual and the P6/P12 manual for the appropriate command entries and flag verifications.

1. Connect the test configuration as depicted in figure 4-1. Apply power to the UUT and set the line voltage to 115 V ac by use of the variac and allow twenty minutes for stabilization.

2. Connect a DMM across capacitor A1C6 and adjust potentiometer A1R55 for a 16.30 ±0.01 reading on the DMM.

3. Jumper connector J2 pins 20 and 4 of the UUT to provide an output relay close stimulus.

4. Place a short across connector J2 pins 14 a 1 to provide a 0 V programming stimulus. Connect a DMM across connector J3 pins C and D. Ensure that the load switch is open. Adjust potentiometer A1R9 V ZERO for a DMM reading of 0.000 ±0.01 V. Adjust front panel voltmeter mechanical zero for a zero indication on the front panel voltmeter.

5. Remove the short from across connector J2 pins 14 and 1 and apply 10.000 V to connector J2 + to pin 14 and - to pin 1 to provide a 500 V programming stimulus. Connect a DMM across test points A1TP1 and A1TP2. Adjust potentiometer A1R1, V CAL for a DMM reading of 10.000 ±0.001 V. Adjust meter option pcb potentiometer R102 for a 500 V (full scale) indication on the front panel voltmeter.

6. Connect the DMM across connector J3 pins C and D and adjust potentiometer A1R28 $-V_N$ CAL for a DMM reading of 500.00 ±0.03 V.

7. Place a short across connector J2 pins 17 and 2 to provide a 0 A programming stiiumuls. Connect a DMM across the series shunt resistor (R_S). Close the test configuration load switch and load shorting switch. Adjust potentiometer A1R15 I ZERO for 0 ±0.1 mA

current by nomitoring the voltage drop across the series shunt resistor. Adjust front panel ammeter mechanical zero for a zero indication on the front panel ammeter.

8. Remove the short across connector J2 pins 17 and 2, and apply 10.000 V to connector J2 + to pin 17 and - to pin 2 to provide a 1 A programming stimulus. Slowly load the UUT to its full rated output, while monitoring the current with a DMM connected across the series shunt resistor (R_S) and the voltage with a DMM connected across the sense pins of connector J3 pins C and D, and by adjusting the voltage source applied to connector J2 pins 14 and 1.

9. Adjust potentiomater A1R12 I CAL for a 1.0000 ±0.0001 A current limit by monitoring the voltage drop across the series shunt resistor. Adjust meter option pcb potentiometer R103 for a 1 A (full scale) indication on the front panel ammeter.

4-22. Performance Test

4-23. The following performance test is provided to verify the performance specifications of the HFP500-1 Power Supply given in chapter 1 of this manual. The performance test is performed using a P6/P12 Programmer with it's DAC-4 output connected to J2 of the UUT. Refer to the systems level manual for the appropriate command entries and flag verification. The test configuration required to perform this test is depicted in figure 4-1.

4-24. HRP500-1 Power Supply Performance Test

1. Configure an ITT Connon PT0614-5P output mating connector with the load resistor (R_L), series shunt resistor (R_S) load switch, load shorting switch and sense wiring as shown in figure 4-1. The switches and wiring must be capable of handeling 1 ampere.

2. Connect the P6/P12 Programmer to the UUT programming connector J2. Apply line power via a variac to the UUT connector J1. Line power should be set at 115 V ac unless otherwise noted.

3. Ensure that the load switch is open and program the UUT to reset, then set voltage to 0.000, current to 1.000 and voltage limit to 550.000. Measure the voltage with a DMM at the output connector. Specification: 0.000 ±0.090 V. Verify that the UUT front panel voltmeter indicates 0 ±5 V. Verify that the VOLTAGE MODE (green) and the CLOSED (amber) LEDs are illuminated and that the voltage mode and output relay close flags are active.

4. Enter an open command and verify that the CLOSED LED extinguishes and the output relay close flag goes inactive.

5. Set voltage to 500.000 and verify that the UUT front panel voltmeter indicates 500 ±10 V. Verify that the output relay is open by measuring the output at J3 with a DMM for a zero volt reading.

6. Enter a close command, close the load switch and adjust the load for voltage mode operation with approximately 0.98 A of load current. Measure the UUT output at J3. Specification: 500 ±0.21 V.

7. Close the load shorting switch, set current to 0.0000 and measure the voltage drop across the shunt resistor (R_S) to determine the load current. Specification: 0.0000 ±0.00047 A. Verify that the UUT front panel ammeter indicates 0 ±0.01 A. Verify that the

CURRENT MODE (amber) LED is illuminated and that the VOLTAGE MODE (green) LED is extinguished. Verify that the current mode flag is active.

8. Set current to 1.000 and measure the voltage drop across the shunt resistor to determine the load current. Specification: 1.000 ±0.0026 A. Verify that the UUT front panel ammeter indicates 1 ±0.02 A.

9. Open the load shorting switch. Increase the load resistance so that the UUT output voltage rises to 490 V or greater, while remaining in the current mode. Measure the voltage drop across the shunt resistor to determine the load current. The differences between this reading and the reading at near zero volts taken in step 7 must not exceed 5 mV.

10. Increase the load resistance so that the UUT just goes into its voltage mode, i.e., 500 V at >0.98 A. Measure and record the UUT's output voltage, the change in output voltage must not exceed 5 mV.

11. Close the load switch and adjust the load resistance for a UUT current mode operation of 1 A at 490 V or greater. Measure the voltage drop across the shunt resistor while changing the line voltage from 103 to 127 V ac. The resultant load current change must be less than 0.1 mA.

12. Adjust the load resistance to place the UUT into it's voltage mode at 500 V and 0.98 A or greater. Measure the UUTs output voltage while changing the line voltage from 103 to 127 V ac. The output voltage change must be less than 5 mV.

13. Open the load switch and connect an rms voltmeter across the load. Close the load switch and adjust the load resistance for a UUT output of 500 V at 0.98 A or greater voltage mode operation. The PARD must not exceed 10 mV as measured on the rms voltmeter.

14. Open the load switch and adjust the load for exactly 490 ohms using an ohmmeter. Close the load switch and measure the rms voltage across the load in mV. Divide the rms reading by the load resistance (490) to determine the PARD in mA. The PARD must not exceed 0.5 mA.

15. Enter an open command and set the voltage 50.000 V and the current to 0.010 A. Open the load switch and connect an adjustable 1 A power supply in series with the shunt series resistor across the output of the UUT, positive to to positive and negative to negative. Set the output of the 1 A power supply to zero volts.

16. Enter a close command and increase the voltage of the external 1 A power supply to 100 V and measure the voltage drop across the shunt resistor to determine the pull down current. The pull down current should be 0.15 ±0.02 A. Verify that the OV (red) LED illuminates and that the overvoltage flag is active.

CHAPTER 5

REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This chapter contains the parts lists for each assembly in the HFP500-1 Power Supply. Chapter 7 shows the assemblies where the listed parts are installed. Ordering information is included and should be used when purchasing parts from the factory. Explanation of the column listings and Table 5-1 Manufacturer's Code-To-Name Index are also included.

5-3. PART ORDERING INFORMATION

5-4. To order a part from the Replaceable Parts List, state the Systron Donner part number, indicate the quantity required and address the order to the nearest Systron Donner Sales or Service Center.

5-5. To order a part not listed in the Replaceable Parts List, state the instrument model number, instrument serial number, the description and function of the part and the number of parts required. Address the order to the nearest Systron Donner Sales or Service Center.

5-6. PARTS LISTS

5-7. Replaceable parts lists are listed for each assembly, sub-assembly in the unit. Each column in the parts lists provides specific information relating to the listed parts as follows:

(1) ITEM: This is the find number column and list those find numbers as called out on the respective assembly drawing.

(2) REFERENCE DESIGNATOR: Reference numbers applicable to assemblies are listed in alphanumeric order.

(3) COMPONENT NOMENCLATURE AND DESCRIPTION: Component names and specifications are provided in these columns and include value, tolerance, wattage rating, working voltage, construction, etc.

(4) MANUFACTURER'S CODE: H4-2 Federal Supply Code numbers are listed to identify component manufacturers. A Manufacturers Index is provided in this chapter for cross reference.

(5) MANUFACTURER'S PART NUMBER: True manufacturer part numbers are listed in this column.

(6) SD STOCK NUMBER: The Systron Donner stock number is listed in this column.

(7) T/Q (Total Quantity): This quantity, appearing after an item entry, indicates the number of times the component is used in that assembly. The total quantity for each part is given only once-at the first appearance of the part number in the list.

Table 5-1. Manufacturer's Code-To-Name Index

Mfr. Code	Manufacturer Name	Address	Zip Code
00779	Amp Inc.	Harrisburg, PA	17105
01121	Allen Bradley Co.	Milwaukee, WI	53203
03296	Union Plastics Corp. Nylon Molding Div.	Kearny, NJ	07032
03508	General Electric Co. Semiconductor Products Div.	Auburn, NY	13021
03877	Transitron Electronic Corp.	Wakefield, MA	01880
04222	AVX Ceramics Div.-AVX Corp.	Myrtle Beach, SC	29577
04713	Motorola Semiconducts Prod.Div.	Phoenix, AZ	85008
06540	Mite Corp. Amatom Electronic Hardware Div.	New Haven, CT	06515
06915	Richco Plastic Co.	Chicago, IL	60646
07263	Fairchild Camera and Instrument Corp. Semiconductor Div.	Mountain View, CA	94042
12014	Chicago Rivet and Machine Co.	Naperville, IL	60540
14298	American Components Inc. RPC Division	Conshohocken, PA	91428
14752	Electro Cube Inc.	San Gabriel, CA	91776
15915	Tepro of Florida Inc.	Dunedin, FL	33528
17117	Electronic Molding Corp.	Woonsocket, RI	02895
24355	Analog Devices Inc.	Norwood, MA	02062
27014	National Semiconductors Corp.	Santa Clara, CA	95051
27264	Molex Inc.	Lisle, IL	60532
28480	Hewlett-Packard Co.	Palo Alto, CA	94304
28520	Heyman Mfg. Co.	Kenilworth, NJ	07033
30487	Huntington Electric Inc.	Huntington, IN	46750
31433	Union Carbide Corp.	Greenville, SC	29606
50522	Monsanto Co. Electronic Special Products	Cupertino, CA	95014
52542	Systron Donner Corp. Instrument Div.	Concord, CA	94518
55210	Gettig Engineering and Mfr.	Spring Mill, PA	16875
56289	Sprague Electric Co.	North Adams, MA	01247
57771	E. B. Stimpson Co.	Bayport, NY	11705
70903	Belden Corp.	Geneva, IL	60134
71279	Rexnard Inc. Specialty Fastener Div.	Paramus, NJ	07652
71590	Globe-Union Inc. Centralab Electronics Div.	Fort Dodge, IA	50501
73138	Beckman Instruments Inc. Helipot Div.	Fullerton, CA	92634
74193	Heinemann Electric Co.	Trenton, NJ	08650
75915	Tracor Littlefuse Inc.	Des Plaines, IL	60016
77969	Rubbercraft Corp. of Calif. Ltd.	Torrance, CA	90507
78189	Illinois Tool Works Inc. Shakeproof Div.	Elgin, IL	60120

Table 5-1. Manufacturer's Code-To-Name Index (Cont'd)

Mfr. Code	Manufacturer Name	Address	Zip Code
78480	Borg-Warner Corp	Decautur, IL	62525
79963	Zierick Mfg. Co.	Mount Kisco, NY	10549
80205	National Aerospace Standard		
80294	Bourns Inc. Instrument Division	Riverside, CA	92506
81349	MIL Specifications		
81483	International Rectifier Corp.	Los Angeles, CA	90069
82389	Switchcraft Inc.	Chicago, IL	60630
83330	Herman H. Smith Inc.	Brooklyn, NY	11207
86927	Sealcraft Co.	Ft. Worth, TX	75265
88044	Aeronautical Standards Group		
88245	Litton Systems Inc. USECO Div.	Van Nuys, CA	91409
91506	Augat Inc.	Attleboro, MA	02703
91637	Dale Electronics Inc.	Columbus, NE	68601
92702	IMC Magnetics Corp.	Westbury Long Island, NY	11591
94222	Southco Inc.	Lester, PA	19113
95348	Gordos Corp.	Bloomfield, NJ	07003
96733	San Fernando Electric Mfg. Co.	San Fernando, CA	91341
96906	MIL Specifications		
98159	Rubber Teck Inc.	Gardena, CA	90247

TITLE	HFP500-1 Shipping Assembly 06587501 Rev C (Figure 6-1)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1		COVER, Top	52542	06579201	06579201	1
2		ASSEMBLY, Test	52542	06575601	06575601	1
7		LINE CORD	70903	17502	117680	1
8		SCREW, PHMS 6-32 x 3/8	96906	MS51957-28	10063206	1
9		WASHER, Int Tooth No. 6	96906	MS35333-71	100647	1
10		WASHER, Flat No. 6	86928	5710-23-10	100662	1
11		SCREW, FHMS 6-32 x 3/8	96906	MS24693-C26	10073106	2
12		SCREW, PHMS 6-32 x 3/8 Black Oxide	96906	MS51957-28B	12304706	2
13		LABEL, Foilcal Caution HV	52542	065535	065535	2

TITLE	Test Assembly 06575601 Rev A (Figure 6-2)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1		ASSEMBLY, Front Panel	52542	06584301	06584301	1
2	A1	ASSEMBLY, Control PC	52542	06582901	06582901	1
3		ASSEMBLY, Chassis	52542	06596901	06596901	1
5	A3	ASSEMBLY, Relay Board PC	52542	06574701	06574701	1
8		WASHER, Int Tooth No. 6	96906	MS35333-71	100647	2
9		WASHER, Flat No. 6	86928	5710-23-10	100662	2
10		SCREW, PHMS 6-32 x 3/8	96906	MS51957-28	10063206	1

TITLE	Front Panel Meter Assembly 06584301 Rev A (Figure 6-15)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1		PANEL, Front	52542	06575103	06575103	1
2		HANDLE	06540	10854-A-0832-2	11971201	1
3		SCREW, FHMS 8-32 x 1/2	96906	MS24693-C50	10074308	2
4		FOILCAL, HFP500-1	52542	781804	781804	1
5	M101	ASSEMBLY, Volt Meter	52542	06584401	06584401	1
6	M102	ASSEMBLY, Ammeter	52542	06584501	06584501	1
7		SCREW, 4-40 x 3/8	96906	MS51957-15B	12305906	3
8		ASSEMBLY, Meter Cal PC	52542	06574801	06574801	1
9		FOILCAL, Closed	52542	06591701	06591701	1
10		FASTENER, Cap 8-32	94222	51-17-809-24	11971001	2

TITLE	Meter Cal PC Assembly 06578401 Rev B (Figure 6-16)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1		BOARD, PC	52542	06578301	06578301	1
	R101	RESISTOR, MF 9.53 k 1%, 1/8 W	81349	RN60D9531F	106328	1
	R102	RESISTOR, Variable 1 k 10%, 1/2 W	73138	72XL RIK	117121	1
	R103	RESISTOR, Variable 100 Ω 10%, 3/8 W	73138	89PR100	102240	1
2		SPACER, Swage 4-40	06540	9536B-A-0440-17	101062	3
		TERMINAL, Swage Bifur	88245	2000B-1	100482	3

REPLACEABLE PARTS LIST

TITLE Chassis Assembly 06596901 Rev C (Figure 6-3)

ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1		CHASSIS, Fab	52542	06577201	06577201	1
2	J2-P1	ASSEMBLY, Cable	52542	06585601	06585601	1
3	CB1	CIRCUIT BREAKER	74193	JA1-AB-A-10-20	119375	1
4	J1	RECEPTICAL	82389	EAC-301	101288	1
5		ASSEMBLY, Series Pass Heatsink	52542	06590601	06590601	1
6	B1	FAN	92702	WS2107FL	106664	1
7		PLATE, Cover	52542	055552	055552	1
8		SPRING	52542	11981701	11981701	1
9	J3-P5	ASSEMBLY, Cable	52542	06592501	06592501	1
12	T1	ASSEMBLY, Transformer	52542	06597301	06597301	1
11		ASSEMBLY, PC Support Bracket	52542	06583101	06583101	1
13		ASSEMBLY, Capacitor Bracket	52542	06597401	06597401	1
14		ASSEMBLY, Capacitor Bracket	52542	06597402	06597402	1
15		WASHER, Flat No. 8	96906	MS15795-807	100705	6
16		NUT, Hex 8-32	78189	51-101800-01	100940	7
17		NUT, Kep small 6-32	78189	511-061800-01	112472	7
18		SCREW, PHMS 6-32 x 1/2	96906	MS51957-30	10063208	8
19		WASHER, Flat No. 6	96906	By Description	112604	1
20		TIE, Cable	06915	EZ-11	11973501	3
21		NUT, Kep 4-40	78189	511-041800-00	100941	8
22		SCREW, PHMS 4-40 x 7/16	96906	MS51957-16	10062607	3
23		SCREW, PHMS 4-40 x 3/8	96906	MS51957-15	10062606	6
24		GROMMET	28520	2020/SB-375-3	11983001	2
25		SCREW, FHMS 6-32 x 5/16	96906	MS24693-C25	10073105	2
26		WASHER, Split No. 6	96906	MS35338-136	100712	1
28		SCREW, PHMS 6-32 x 3/8	96906	MS51957-28	10063206	1
29		SCREW, FHMS 6-32 x 5/16	96906	MS24693-C25	10073105	1
30		WASHER, Flat No. 10	96906	MS15795-808	1006480	12
31		NUT, Hex 10-32	78189	511-101800-50	100939	4
32		NUT, Speed No. 6	78553	C7852-632-24	123048	1
33		SCREW, FHMS 6-32 x 1/4	96906	MS24693-C24	10073104	2
34		ASSEMBLY, Indicator PC	52542	06578801	06578801	1
36	A2	ASSEMBLY, Rectifier PC	52542	06575801	06575801	1
37	A4	ASSEMBLY, Rectifier PC	52542	06575802	06575802	1
39		SPACER, (Not always Installed)	06540	9286A-194	103072	A/R
40		SCREW, PHMS 10-32 x 1/2	96906	MS51958-63	10064408	8
41		WASHER, Split No. 10	96906	MS35338-138	100714	8
42		WASHER, Flat No. 4	80205	NAS620-42	100683	2
43		SCREW, FHMS 8-32 x 1/2	96906	MS24693-C50	10074308	4

TITLE	Chassis Assembly 06596901 (Cont'd)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
46		WASHER, Nylon No. 4	68928	7274777	112580	A/R
47		SCREW, PHMS 4-40 x 3/4	96906	MS51957-19	10062612	A/R
48		WASHER, Flat No. 4	96906	MS15795-803	100703	A/R
49		SCREW, PHMS 6-32 x 3/4	96906	MS51957-32	10063212	A/R
51		SCREW, PHMS 10-32 x 5/8	96906	MS51958-64	10064410	8
53		LABEL	52542	07382601	07382601	1

REPLACEABLE PARTS LIST

TITLE	Series Pass Heatsink Assembly 06590601 Rev B (Figure 6-4 and 6-5)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1	A5	ASSEMBLY, Heatsink PC	52542	06588501	06588501	1
2	A6	ASSEMBLY, Heatsink PC	52542	06588502	06588502	1
3		FAB, Alignment Bar	52542	06585501	06585501	2
4		FAB. Alignment Bar	52542	06585502	06585502	2
5		FAB, Heatsink Bracket	52542	06576201	06576201	2
6		SCREW, FHMS 10-32 x 1	96906	MS24693-C276	10075816	4
7		FAB, Heatsink	52542	06574502	06574502	4
8	Q1 thru Q16	TRANSISTOR, MOSFET 350 V	04713	IRF333	11986001	16
9	Q17	TRANSISTOR, MOSFET 500 V	04713	IRF432	11986101	2
	Q18	Same as Q17				
10	XQ1 thru XQ18	SOCKET, Transistor TO3	06776	MD-3452-G	830099	18
11		INSULATOR, TO3	08289	DM-111	103358	18
12	S1	SWITCH, Thermal	52542	06588201	06588201	1
13	R21 thru R36	RESISTOR, CC 1 kΩ 5%, 1/4 W	01121	CB1025	101569	18
	R41	Same as R21				
	R42	Same as R21				
15		NUT, Kep 10-32	78189	511-101800-50	100939	8
16		ASSEMBLY, Cable	52542	06592701	06592701	1
18		SCREW, PHMS 6-32 x 5/8	96906	MS51957-31	10063210	36
19		WASHER, Int Tooth No. 6	96906	MS35333-71	100647	36
20		SCREW, PHMS 4-40 x 5/16	96906	MS51957-14	10062605	4
21		WASHER, Split No. 4	96906	MS35338-135	100711	4
22		WASHER, Flat No. 4	96906	MS15795-803	100703	4
23		SCREW, PHMS 2-56 x 5/16	96906	MS51957-4	10062505	2
24		WASHER, Int Tooth No. 2	96906	MS35333-69	100701	2
25		LABEL	52542	065535	065535	2
26		SCREW, PHMS 10-32 x 1	96906	MS51958-67	10064416	4

TITLE	Transformer Assembly 06597301 Rev B (Figure 6-19)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1	T1	TRANSFORMER, Power	52542	504363	504363	1
2		FAB, Bracket Transformer	52542	06590301	06590301	1
3		FAB, Bracket Transformer	52542	06590302	06590302	1
4	C1 thru C4	CAPACITOR, Ceramic 3000 pF 20%, 500 V	71590	DD-302	100059	4
5		SCREW, Round Head MS	52542	By Description	11979901	2
6		WASHER, Flat No. 10	96906	MS15795-808	100648	4
7		NUT, Kep 10-32	78189	511-101800-50	100939	2
8		BUSHING	83330	2537	103655	4
10		ASSEMBLY, Bracket Relay	52542	06597101	06597101	1
11		WASHER, Flat No. 6	96906	By Description	112604	2
12		NUT, Kep 6-32	78189	511-061800-00	100862	2
13		GROMMET	03296	G51H-B	100913	A/R

TITLE	Relay Bracket Assembly 06597101 Rev B (Figure 6-12)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1		BRACKET, Fab	52542	06576601	06576601	1
2	C5	CAPACITOR, Mylar 1 µF 1 kV, 20%	14752	520BIG105M	11984701	1
3		SPACER	52542	T990450	T990450	4
4		TIE, Cable	06915	EZ-11	11973501	2
6		SCREW, PHMS 4-40 x 3/16	96906	MS51957-12	10062603	2
7		TERMINAL, 4-40	17117	2304-14-1	860020	2
8		WASHER, Int Tooth No. 4	96906	MS35333-70	100794	2

TITLE	Control Board Bracket Support Assembly 06583101 Rev A (Figure 6-18)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1		FAB, Bracket Support	52542	06583201	06583201	1
2		CONNECTOR, PC Edge	00779	582388-9	101285	Ref
3		TIE, Cable	98159	2829-115-4	100848	3
4		ASSEMBLY, Cable P4-P2	52542	06593001	06593001	1
5		SCREW, FHMS 6-32 x 3/8	96906	MS24693-C26	10073106	2
6		WASHER, Flat No. 6	96906	By Description	112604	2
7		NUT, Kep 6-32	78189	511-061800-00	100862	2
8		NUT, Pushon 6-32	78553	C7853-632-24	123048	1
9		BUMPER	77969	6409	117882	1

TITLE	Capacitor C1,C2 Bracket Assembly 06597401 Rev A (Figure 6-13)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1		BRACKET, Fab	52542	06588301	06588301	1
2		CLIP	86927	4543-137-68-20	11988402	4
3		RIVET, Tubular	12014	R-3472X5/32 NICL	100653	8
4		WASHER, Flat No. 4	80205	NAS620-42	100683	8
5	C1	CAPACITOR, El Can 850 µF -10/50%, 200 V	56289	36DX851F200 AC2B	11985901	2
	C2	Same as C1				
6		TUBE, Shrink 3/4	52542	By Description	118803	A/R

TITLE	Capacitor C3,C4 Bracket Assembly 06597402 Rev A (Figure 6-14)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1		BRACKET, Fab	52542	06588301	06588301	1
2		CLIP	86927	4543-137-68-2C	11988402	4
3		RIVET, Tubular	12014	R-3472X5/32 NICL	100653	8
4		WASHER, Flat No. 4	80205	NAS620-42	100683	8
5	C3	CAPACITOR, El Can 850 µF -10/50%, 200 V	56289	36DX851F200 AC2B	11985901	2
	C4	Same as C3				
6		TUBE, Shrink 3/4	52542	By Description	118803	A/R

TITLE	Indicator PC Assembly 06578801 Rev A (Figure 6-17)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		BOARD, PC	52542	06578701	06578701	1
	DS1	LED, Green	50522	MV5253 W/MTGGRM	103202	1
	DS2	LED, Orange	50522	MV5153 W/MTGGRM	103201	2
	DS3	Same as DS2				
	DS4	LED, Red	50522	MV5754	103960	1
7		ASSEMBLY, Cable	52542	06589101	06589101	1
3		TERMINAL	88245	2000B-1	100482	5

TITLE	A1, Control Board PC Assembly 06582901 Rev F (Figure 6-6)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		BOARD, PC	52542	06582801	06582801	1
	C1	CAPACITOR, El Ax 1000 µF -10+50%, 35 V	74840	108TTA035A	11981301	1
	C2	CAPACITOR, El Ax 220 µF -20/75%, 35 V	74840	227TTA035A	11982401	1
	C3	CAPACITOR, Tant 15 µF 10%, 20 V	56289	150D156X9020B2	100211	1
	C4	CAPACITOR, Ceramic 1 µF 20%, 50 V	56289	5CZ5U105X0050C5	100176	3
	C5	Same as C4				
	C6	Same as C4				
	C7	CAPACITOR, DP Ceramic 47 pF 5%, 100 V	96733	DB44BY470J	117359	1
	C8	CAPACITOR, Tant 56 µF 10%, 6 V	56289	150D566X900B2	100225	2
	C9	Same as C8				
	C10	Not Used				
	C11	CAPACITOR, DP Ceramic .033 µF 10%, 50 V	71590	CW20C333K	11979801	1
	C12	CAPACITOR, DP Ceramic .015 µF 10%, 50 V	71590	CW15C153K	11990701	1
	C13	CAPACITOR, DP Ceramic 470 pF 5%, 100 V	96733	DB45BY471J	117637	1
	C14	CAPACITOR, DP Ceramic 27 pF 5%, 100 V	96733	DB44BY270J	117640	1
	C15	CAPACITOR, DP Ceramic 0.01 µF 20%, 100 V	04222	3429100C103M	117570	1
	C16	Not Used				
	C17	CAPACITOR, DP Ceramic 2200 pF 10%, 100 V	96733	DB44BX222K	116501	1
	C18	CAPACITOR, DP Ceramic 100 pF 5%, 100 V	96733	DB44BY101J	117628	1
	C19	CAPACITOR, Ceramic 0.1 µF 20%, 50 V	56289	5C023104X0500C5	100178	3
	C20 thru C23	Not Used				
	C24	Same as C19				
	C25	Same as C19				
	C26	CAPACITOR, Ceramic 0.001 µF 10%, 100 V	04222	3418100C102K	117568	1

TITLE A1, Control Board PC Assembly 06582901 (Cont'd)

ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	CR1	DIODE, Bridge Rectifier	04713	MDA101A	11982501	1
	CR2	JUMPER	55210	L-2007-1	102879	10
	CR3	DIODE, Signal 125 V	07263	FDH300	102703	1
	CR4	DIODE, Zener 13 V	04713	1N964B	100412	1
	CR5	DIODE, Rectifier 50 V	81483	30S05	103252	2
	CR6	Same as CR5				
	CR7 thru CR11	Not Used				
	CR12	DIODE, Signal 50 V	03508	1N4151	100385	9
	CR13	Same as CR12				
	CR14	Same as CR12				
	CR15	Not Used				
	CR16 thru CR19	Same as CR12				
	CR20	Not Used				
	CR21	Same as CR12				
	CR22	Not Used				
	CR23	Same as CR12				
	CR24	Not Used				
	CR25	Not Used				
	CR26	Not Used				
	CR27	Same as CR2				
	CR28	Not Used				
	CR29	Same as CR12				
	CR30	Same as CR12				
	CR31	DIODE, Zener 12 V	04713	1N963B	100390	1
	CR32	DIODE, Zener 4.3 V	04713	1N749A	100419	2
	CR33	Same as CR32				
	CR34	Not Used				
	CR35	Same as CR2				
	CR36	JUMPER, 22 AWG	52542	22 AWG	11 AWG	2
	CR37	Same as CR36				
	J1	SOCKET	91506	524-AG11D	11933801	1
	J2	CONNECTOR, PC 12-pin	27264	22-12-2124	11973201	1
	J3	CONNECTOR, PC 8-pin	27264	22-12-2084	11981001	1
	Q1	TRANSISTOR, SINPN 40 V	04713	2N3904	101377	1
	Q2	TRANSISTOR, SINPN 40 V	04713	2N3906	101378	2

TITLE	A1, Control Board PC Assembly 06582901 (Cont'd)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	Q3	Not Used				
	Q4	Not Used				
	Q5	Same as Q2				
	R1	RESISTOR, Variable 500 Ω 10%, 3/8 W	73138	89PR500	102183	2
	R2	RESISTOR, MF 4.87 k 1%, .1 W	91637	CMF-55-T9	119007	2
	R3	Same as R2				
	R4	RESISTOR, MF 10 k 1%, .1 W	91637	CMF-55-T9	119041	2
	R5	RESISTOR, MF 4.99 kΩ 1%, 0.1 W	81349	RN55D4991F	117576	1
	R6	RESISTOR, CC 10 MΩ 5%, 1/4 W	01121	CB1065	10156401	1
	R7	RESISTOR, CC 3.3 kΩ 5%, 1/4 W	01121	CB3325	101559	1
	R8	RESISTOR, CC 2.4 M 5%, 1/4 W	01121	CB2455	106002	1
	R9	RESISTOR, Variable 20 kΩ 10%, 3/8 W	73138	89PR20K	102470	1
	R10	RESISTOR, CC 2 k 5%, 1/4 W	01121	CB2025	10155301	1
	R11	RESISTOR, WW .1 Ω 3%, 5 W	15915	TSK5 .1 3%	117465	1
	R12	RESISTOR, Variable 10 Ω 20%, 3/8 W	73138	89PR10	102156	1
	R13	RESISTOR, MF 95.3 Ω .1 W, 1%	81349	RN55E95R3F	119937	1
	R14	Same as R4				
	R15	RESISTOR, Variable 10 kΩ 10%, 3/8 W	73138	89PR10K	102472	1
	R16	RESISTOR, CC 1 kΩ 5%, 1/4 W	01121	CB1025	10156901	2
	R17	RESISTOR, CC 6.2 k 5%, 1/4 W	01121	CB6225	10160801	1
	R18	RESISTOR, CC 22 k 5%, 1/4 W	01121	CB2235	10157201	1
	R19	RESISTOR, CC 39 Ω 5%, 1/4 W	01121	CB3905	10173301	1
	R20 thru R25	Not Used				

TITLE	A1, Control Board PC Assembly 06582901 (Cont'd)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	R26	RESISTOR, MF 50.0 k .1 %, 1/8 W	14298	RN60C	106356	1
	R27	RESISTOR, MF 1.00 k .1 %, .13 W	91637	CMF60 T9	103401	1
	R28	Same as R1				
	R29	RESISTOR, MF 9.53 kΩ 1%, 0.1 W	81349	RN55E9531F	119038	1
	R30 thru R33	RESISTOR, MF 121 k 1%, 1/4 W	81349	RN65E1213F	11980301	4
	R34	Same as CR2				
	R35	Not Used				
	R36	RESISTOR, MF 10 k .1%, 1/8 W	80294	3059J-1-502M	106363	1
	R37	RESISTOR, MF 11.0 k .1%, .1W	81349	RN55C1102F	11980401	1
	R38	Not Used				
	R39	Not Used				
	R40	RESISTOR, CC 820 Ω 5%, 1/4 W	01121	CB8215	10156701	1
	R41	Not Used				
	R42	Not Used				
	R43	RESISTOR, CC 15 kΩ 5%, 1/4 W	01121	CB1535	101552	1
	R44	RESISTOR, CC 30 k 5%, 1/4 W	01121	CB3035	10154901	2
	R45	Same as R44				
	R46	RESISTOR, CC 24 kΩ 5%, 1/4 W	01121	CB2435	10155401	4
	R47	Not Used				
	R48	Same as R46				
	R49	Not Used				
	R50	Same as R35				
	R51 thru R54	RESISTOR, CC 1.2 kΩ 5%, 1/4 W	01121	CB1225	10158101	4
	R55	RESISTOR, Variable 5 k 20%, 1/2 W	80294	3339H-1-502	102099	1
	R56	RESISTOR, CC 240 Ω 5%, 1/4 W	01121	CB2415	10158801	1
	R57	Same as R16				
	R58	Not Used				

TITLE	A1, Control Board PC Assembly 06582901 (Cont'd)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	R59	Not Used				
	R60	Same as R46				
	R61	Same as R46				
	R62	RESISTOR, CC 33 kΩ 5%, 1/4 W	01121	CB3335	10157601	1
	R63	RESISTOR, CC 1.3 kΩ 5%, 1/4 W	01121	CB1325	10155601	1
	R64	RESISTOR, CC 100 Ω 5%, 1/4 W	01121	CB1015	101609	1
	R65	Same as CR2				
	TP1	TEST POINT, Brown	91506	8041-1G3	100521	1
	TP2	TEST POINT, Red	91506	8041-1G4	100522	1
	U1	INTEGRATED CIRCUIT Operational Amplifier	27014	LM201AH	025758	1
	U2	INTEGRATED CIRCUIT Operational Amplifier	27014	LF412CH	11982801	1
	U3	INTEGRATED CIRCUIT Operational Amplifier	24355	AD542LH	117838	1
	U4	INTEGRATED CIRCUIT Operational Amplifier	27014	LF411CH	11982701	1
	U5	INTEGRATED CIRCUIT Opto Isolator	50522	MCT6	102858	2
	U6	Same as U5				
	U7	INTEGRATED CIRCUIT Voltage Regulator 15 V	04713	MC7815CT	103039	1
	U8	INTEGRATED CIRCUIT Voltage Regulator	04713	MC7906CT	11980701	1
	U9	INTEGRATED CIRCUIT Voltage Regulator	04713	MC79L15ACP	117261	1
	U10	INTEGRATED CIRCUIT Voltage Regulator	27014	LM317LZ	11980801	1
	U11	INTEGRATED CIRCUIT, CMOS Hex Schmitt Trigger	04713	MC14584BCP	11980901	1
	U12	INTEGRATED CIRCUIT, CMOS Hex Inverter Buffer	04713	MC14049UBCP	103217	1
	U13	INTEGRATED CIRCUIT Operational Amplifier	07263	741TC	106621	1
	W3,6, 10,11	Same as CR2				
2		SPACER, Swage 4-40	71279	1300-9	100492	2
165		SCREW, PHMS 4-40 x 1/4	96906	MS51957-13	10062604	2
166		WASHER, Int Tooth No. 4	96906	MS35333-70	100794	2

TITLE	A2, Rectifier PC Assembly 06575801 Rev B (Figure 6-10)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1		BOARD, PC	52542	06575901	06575901	1
	CR1 thru CR4	DIODE, Rectifier 800 V	04713	1N4006	100427	4
	CR5	DIODE, Rectifier 600 V	04713	1N5001	11973701	1
	R1	RESISTOR, WW 8 k 10 W, 5%	30487	ALSR-10-8000	11973601	2
	R2	Same as R1				
	R3	RESISTOR, CC 1 MΩ 5%, 1/4 W	01121	CB1055	101605	1
2		TERMINAL, Swage	88245	1309B-1	100508	4
3		CONNECTOR, Pin	79963	835	11965901	11
4		JUMPER, Insulated	55210	L-2007-1	102879	1

TITLE	A3, Relay Board PC Assembly 06574701 Rev C (Figure 6-7)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1		BOARD, PC	52542	06574801	06574801	1
	C1	CAPACITOR, Tant .33 µF 35 V, 10%	31433	KR33C35K	100281	1
	C2	CAPACITOR, Ceramic 0.1 µF 20%, 50 V	56289	5C023104X0500C5	100178	1
	C3	CAPACITOR, DP Ceramic 0.01 µF 20%, 100 V	04222	3429100C103M	117570	2
	C4	CAPACITOR, Tant 1 µF 10%, 35 V	56289	150D105X9035A2	100082	2
	C5	Same as C4				
	C6	CAPACITOR, Tant 4.7 µF 10%, 10 V	56289	150D475X9010A2	100205	1
	C7	Same as C3				
	CR1	DIODE, Signal 50 V	03508	1N4151	100385	1
	J1	CONNECTOR, PC 7-pin	27264	09-90-1071	11973801	1
	J2	CONNECTOR, PC 10-pin	27264	22-12-2104	11973001	1
	KS	RELAY, Reed 24 V	95348	652A-241-5D	11979501	1
	KV1	RELAY, Reed 12 V	95348	652A-121-5D	11973901	2
	KV2	Same as KV1				
	Q1	TRANSISTOR, SIPNP 30 V	04713	MPSA14	106616	2
	Q2	Same as Q1				
	R1	RESISTOR, CC 1 k 5%, 1/4 W	01121	CB1025	10156901	1
	R2	RESISTOR, CC 4.7 k 5%, 1/4 W	01121	CB4725	10159801	1
	R3	RESISTOR, CC 20 k 5%, 1/4 W	01121	CB2035	10160701	1
	R4	RESISTOR, CC 5.1 kΩ 5%, 1/4 W	01121	CB5125	10154101	1
	R5	RESISTOR, CC 10 k 5%, 1/4 W	01121	CB1035	10167001	2
	R6	Same as R5				
	R7	RESISTOR, CC 47 kΩ 5%, 1/4 W	01121	CB4735	10157401	2
	R8	Same as R7				
	U1	INTEGRATED CIRCUIT Voltage Regulator	04713	MC78L05ACP	117101	1
	U2	INTEGRATED CIRCUIT, CMOS Quad 2-In NOR Gate	27014	MM74HC266	11979601	1

TITLE	A3, Relay Board PC Assembly 06574701 (Cont'd)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	U3	INTEGRATED CIRCUIT, CMOS Dual One Shot	27014	MM74C221N	11941001	1
	U4	INTEGRATED CIRCUIT Dual Flip Flop	27014	MM74C74	11938301	1

TITLE	A4, Rectifier PC Assembly 06575802 Rev B (Figure 6-11)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1		BOARD, PC	52542	06575901	06575901	1
	CR1 thru CR4	DIODE, Rectifier 800 V	04713	1N4006	100427	4
	CR5	DIODE, Rectifier 600 V	04713	1N5001	11973701	2
	CR6	Same as CR5				
	R1	RESISTOR, WW 8 k 10 W, 5%	30487	ALSR-10-8000	11973601	2
	R2	Same as R1				
	R3	RESISTOR, CC 1 MΩ 5%, 1/4 W	01121	CB1055	101605	2
	R4	Same as R3				
2		TERMINAL, Swage	88245	1309B-1	100508	4
3		CONNECTOR, Pin	79963	835	11965901	11
4		JUMPER, Insulated	55210	L-2007-1	102879	1

TITLE	A5, Series Pass Heat Sink PC Assembly 06588501 Rev C (Figure 6-8)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		BOARD, PC	52542	06588601	06588601	1
	CR6 thru CR8	DIODE, Rectifier 800 V	04713	1N4006	100427	5
	CR9	DIODE, Signal 50 V	03508	1N4151	100385	2
	CR10	Same as CR6				
	CR11	Same as CR9				
	CR12	Same as CR6				
	CR13	DIODE, Zener 5.6 V	03877	1N752A	100376	1
	CR14	DIODE, Zener 6.2 V	03877	1N753A	100387	1
14	F1	FUSE, 3 AG MB, 1.5 A 250 V	75915	31201.5	100588	1
	Q19	TRANSISTOR, SINPN	81349	2N2222	101347	1
	R5	RESISTOR, WW Precision 20 Ω .1 W, .1%	52542	630150	630150	8
	R6	Same as R5				
	R9	Same as R5				
	R10	Same as R5				
	R13	Same as R5				
	R14	Same as R5				
	R17	Same as R5				
	R18	Same as R5				
	R37 thru R40	RESISTOR, CC 10 kΩ 5%, 1/4 W	01121	CB1035	101570	4
	R43	RESISTOR, CC 10 Ω 5%, 1 W	01121	GB1005	101794	1
	R44	RESISTOR, CC 150 k 5%, 1/2 W	01121	EB1545	101481	2
	R45	Same as R44				
	R46	RESISTOR, CC 75 k 5%, 2W	01121	HB7535	11986301	2
	R47	Same as R46				
	R48	RESISTOR, CC 6.2 k 5%, 1/4 W	01121	CB6225	101608	1
	U1	INTEGRATED CIRCUIT Opto Isolator	28480	6N136	103019	1
12		TERMINAL, Swage	88245	1309B-1	100508	57
13		CLIP, Fuse	71400	5678-14	840070	2
15		EYELET	57771	A492	123096	2

TITLE	A6, Series Pass Heat Sink PC Assembly 06588502 Rev A (Figure 6-9)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1		BOARD, PC	52542	06588602	06588602	1
	R7	RESISTOR, WW Precision 20 Ω .1 W, .1%	52542	630150	630150	8
	R8	Same as R7				
	R11	Same as R7				
	R12	Same as R7				
	R15	Same as R7				
	R16	Same as R7				
	R19	Same as R7				
	R20	Same as R7				
2		TERMINAL, Swage	88245	13098-1	100508	27

DRAWINGS

6-1. INTRODUCTION

6-2. This chapter contains the assembly and schematic diagrams for the Model HFP500-1 Power Supply. The parts list contained in chapter 5 relates to the reference designation callouts on the diagrams. Table 6-1 provides a list by figure number of the drawings, with title, drawing number and page number.

Table 6-1. List of Drawings

Figure Number	Drawing Title	Drawing Number	Page Number
6-1	Shipping Assembly	06587501	6-3
6-2	Test Assembly	06575601	6-4
6-3	Chassis Assembly	06596901	6-5
6-4	Series Pass Heat Sink Assembly (Sheet 1 of 2)	06590601	6-6
6-5	Series Pass Heat Sink Assembly (Sheet 2 of 2)	06590601	6-7
6-6	A1, Control Board PC Assembly	06582901	6-8
6-7	A3, Relay Board PC Assembly	06574701	6-9
6-8	A5, Series Pass Heat Sink PC Assembly	06588501	6-10
6-9	A6, Series Pass Heat Sink PC Assembly	06588502	6-11
6-10	A2, Rectifier PC Assembly	06575801	6-12
6-11	A4, Rectifier PC Assembly	06575802	6-13
6-12	Relay Bracket Assembly	06597101	6-14
6-13	Capacitor Bracket Assembly	06597401	6-15
6-14	Capacitor Bracket Assembly	06597402	6-16
6-15	Front Panel Meter Assembly	06584301	6-17
6-16	Meter Calibration PC Assembly	06578401	6-18
6-17	Indicator PC Assembly	06578801	6-19
6-18	Control Board Bracket Support Assembly	06583101	6-20
6-19	Main Transformer Assembly	06597301	6-21
6-20	HFP500-1 Schematic	065749	6-23
6-21	A1, Control PC Assembly Schematic	06598101	6-25

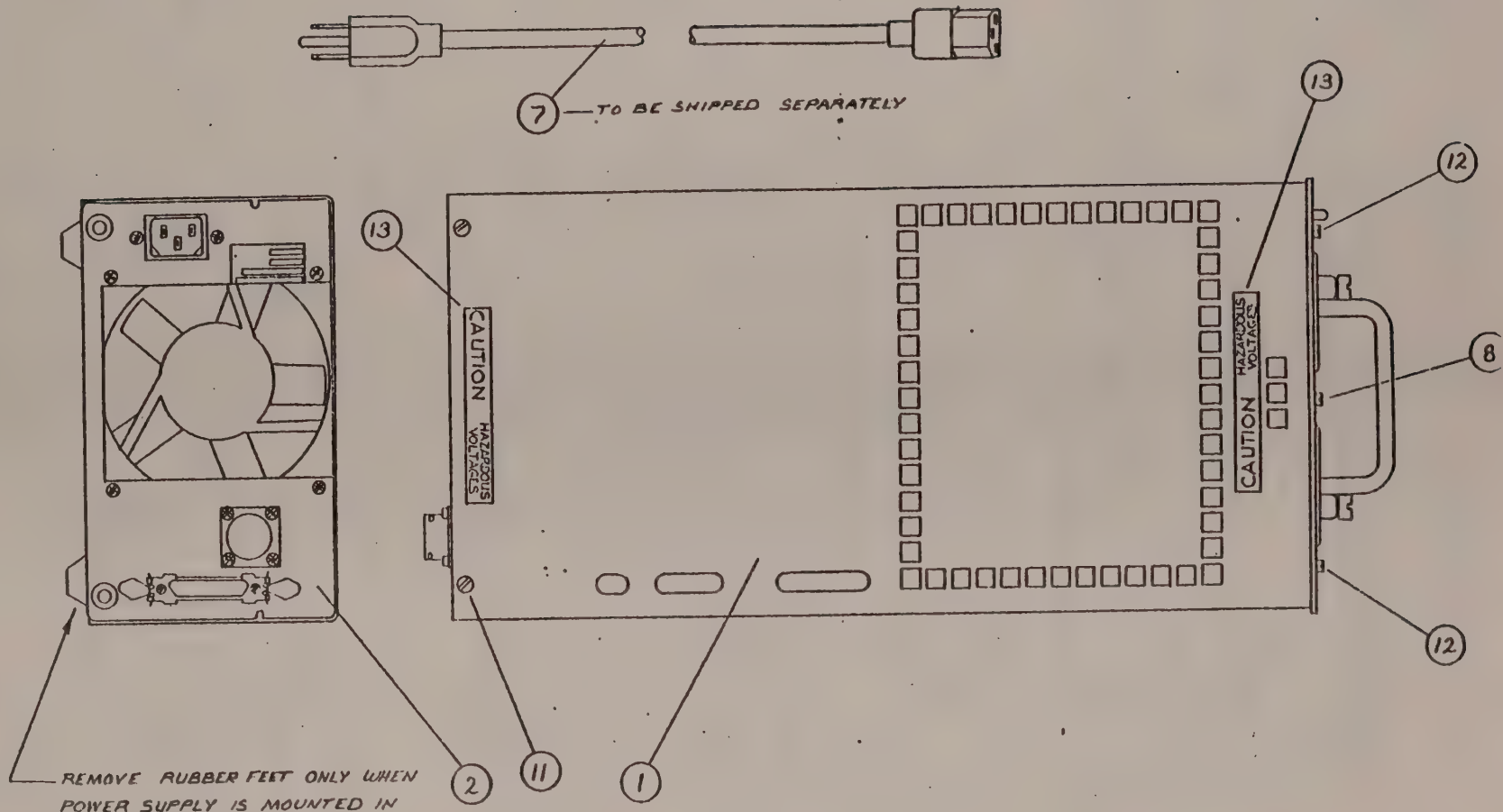
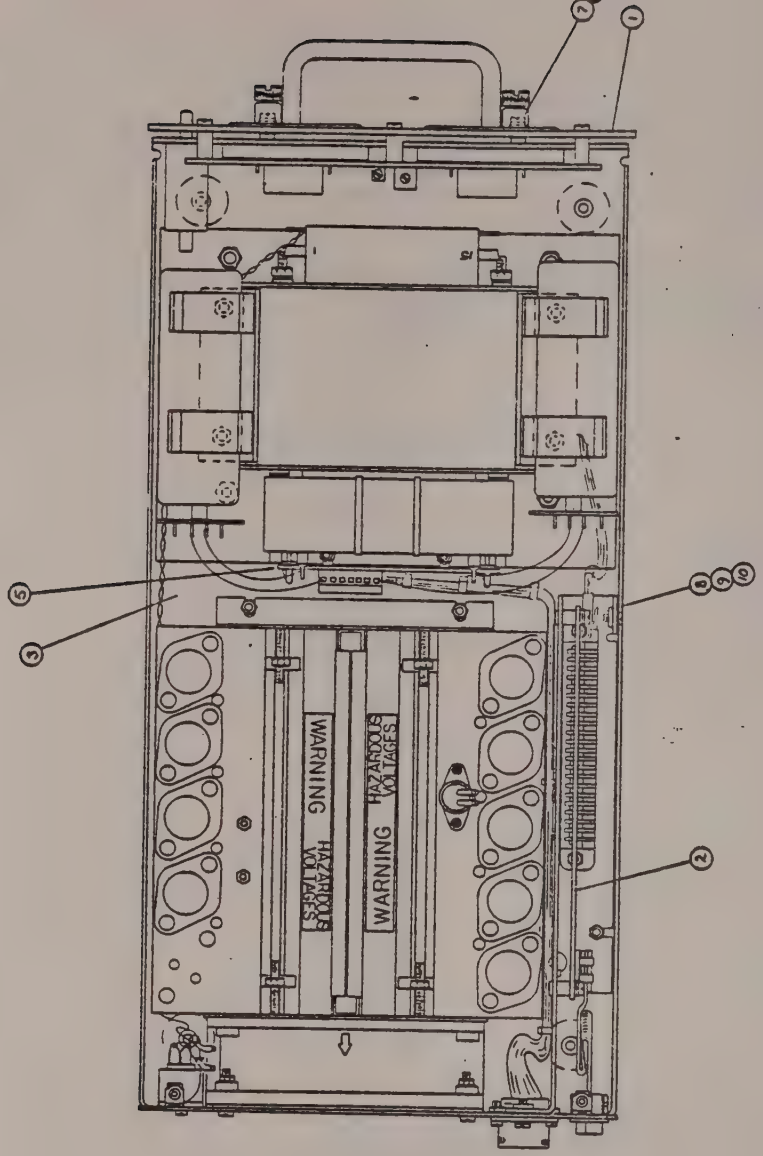


Figure 6-1
HFP500-1 Shipping Assembly
06587501 Rev C



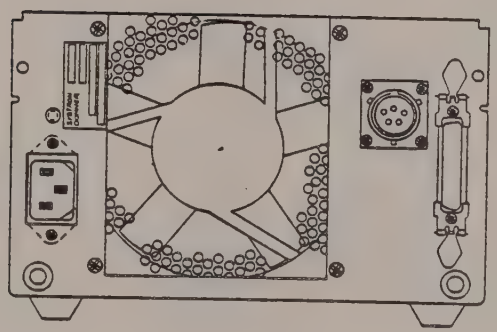


Figure 6-2
Test Assembly
06575601 Rev A

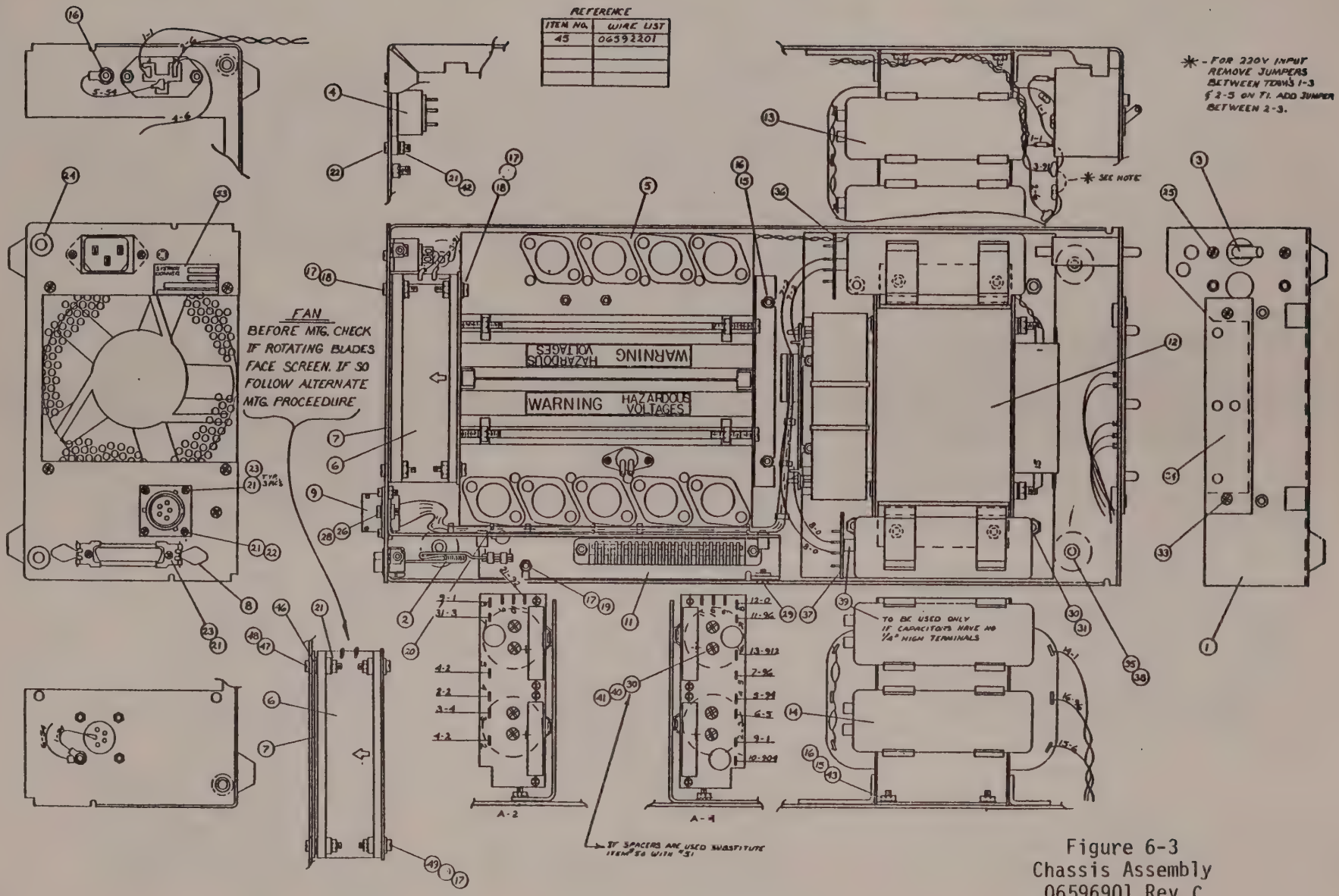

REFERENCE
ITEM NO. | WIRE LIST
45 | 06592201
* - FOR 220V INPUT REMOVE JUMPERS BETWEEN TERMS 1-3 & 2-5 ON T1. ADD JUMPER BETWEEN 2-3.
* SEE NOTE
FAN
BEFORE MTG. CHECK IF ROTATING BLADES FACE SCREEN. IF SO FOLLOW ALTERNATE MTG. PROCEEDURE
WARNING HAZARDOUS VOLTAGES
WARNING HAZARDOUS VOLTAGES
TO BE USED ONLY IF CAPACITORS HAVE NO 1/4" HIGH TERMINALS
IF SPACERS ARE USED SUBSTITUTE ITEM 50 WITH "51"
A-2
A-1

Figure 6-3
Chassis Assembly
06596901 Rev C

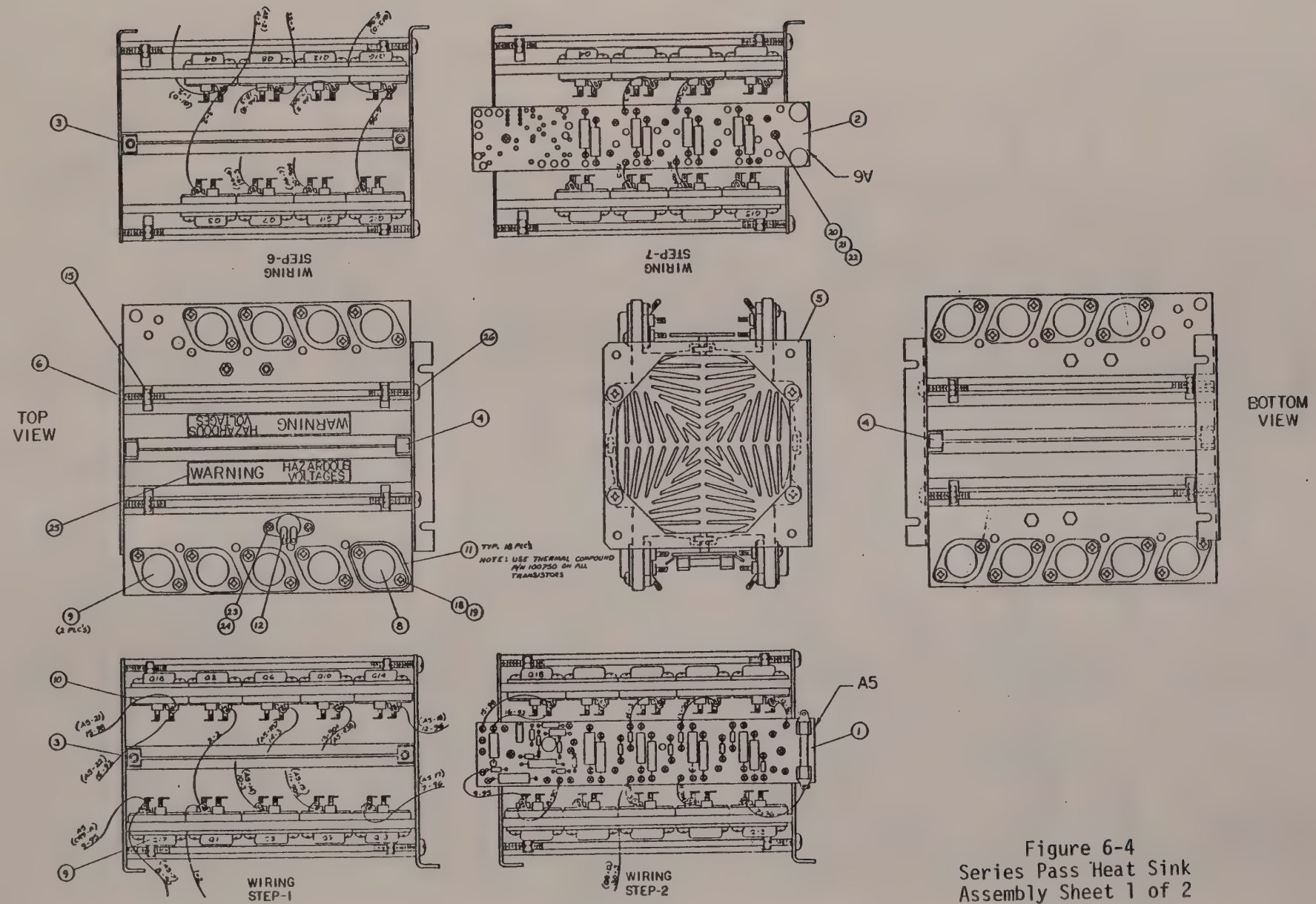


Figure 6-4
Series Pass Heat Sink
Assembly Sheet 1 of 2
06590601 Rev B

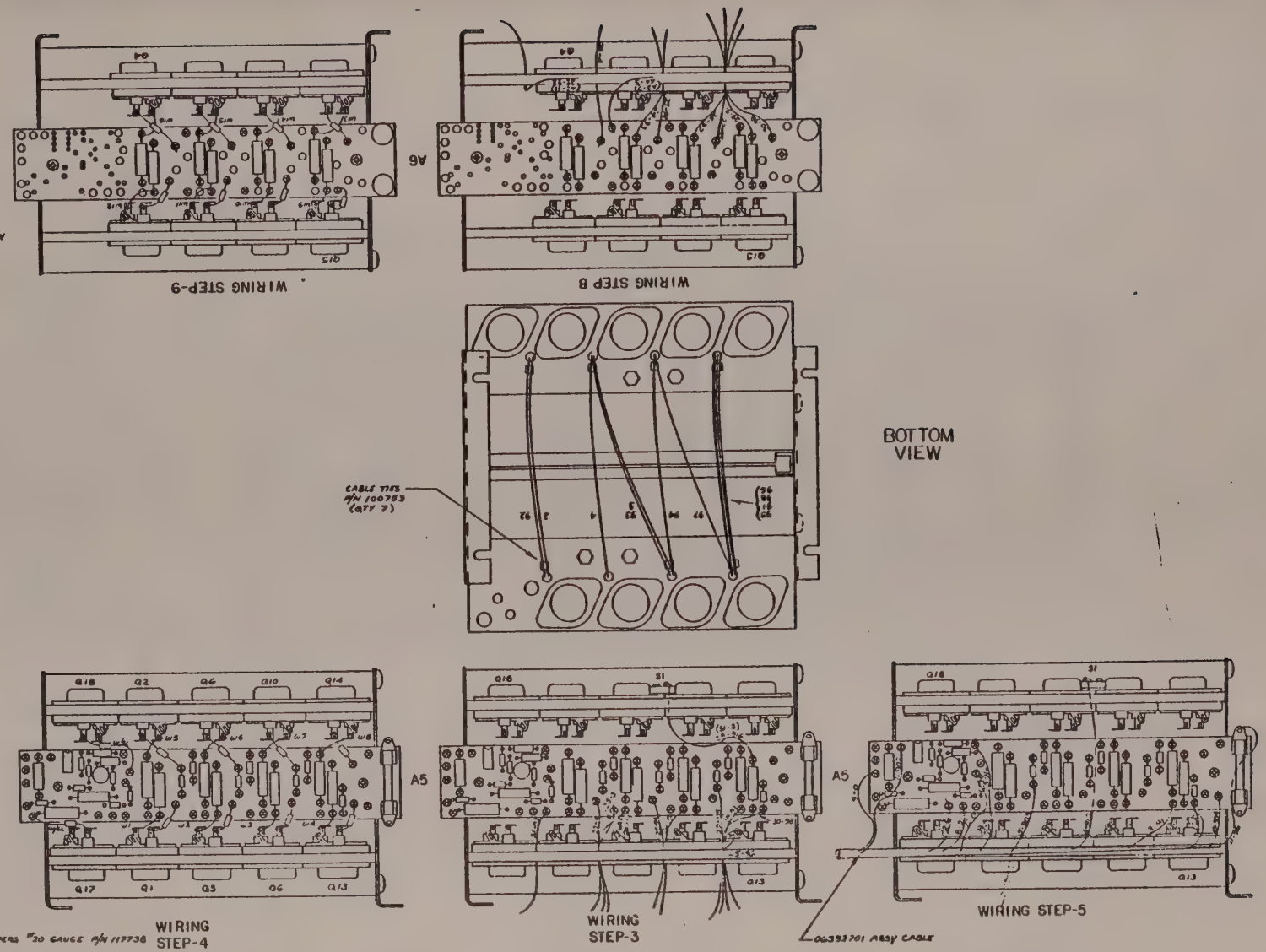


Figure 6-5
Series Pass Heat Sink
Assembly Sheet 2 of 2
06590601 Rev B

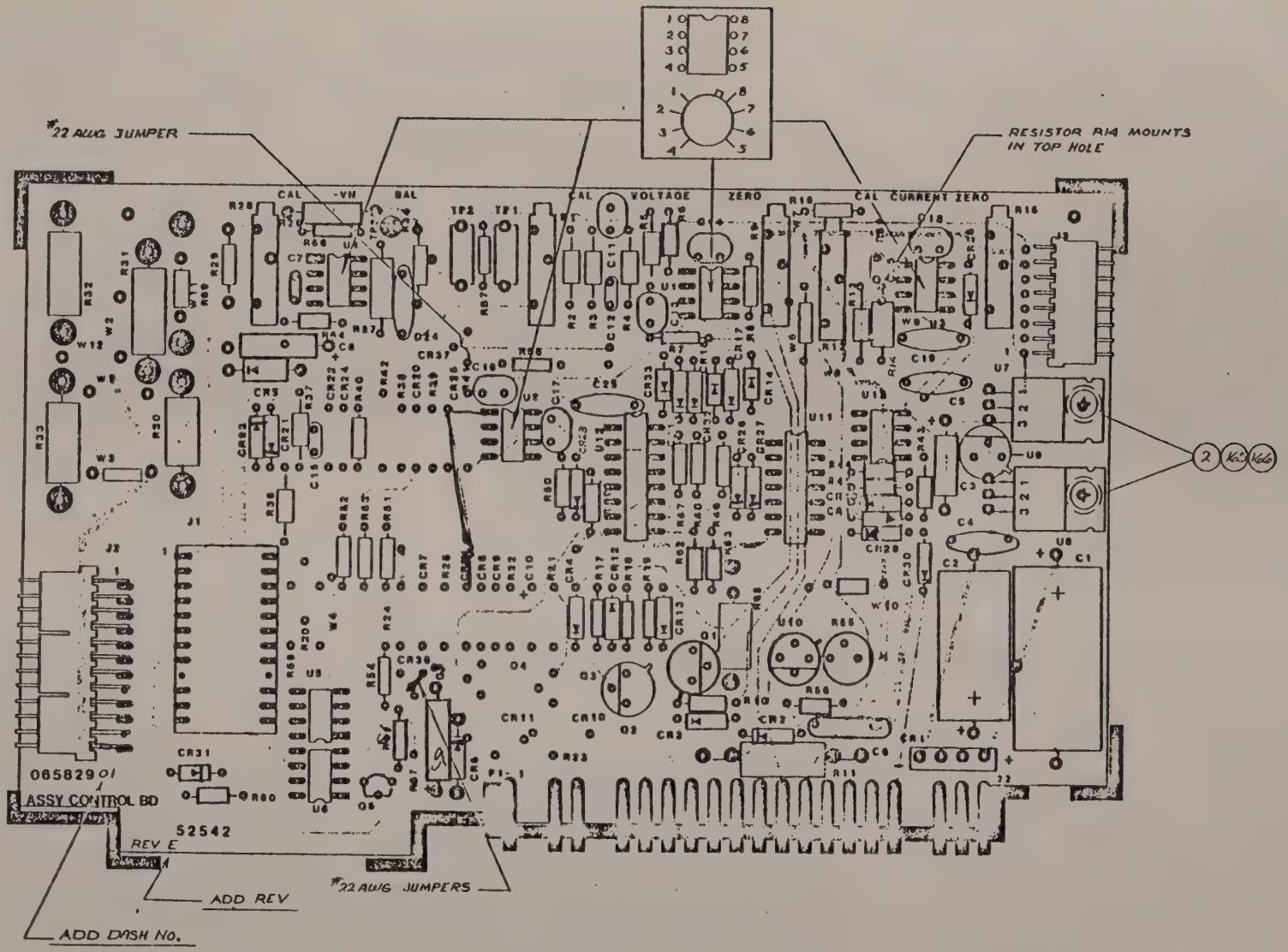
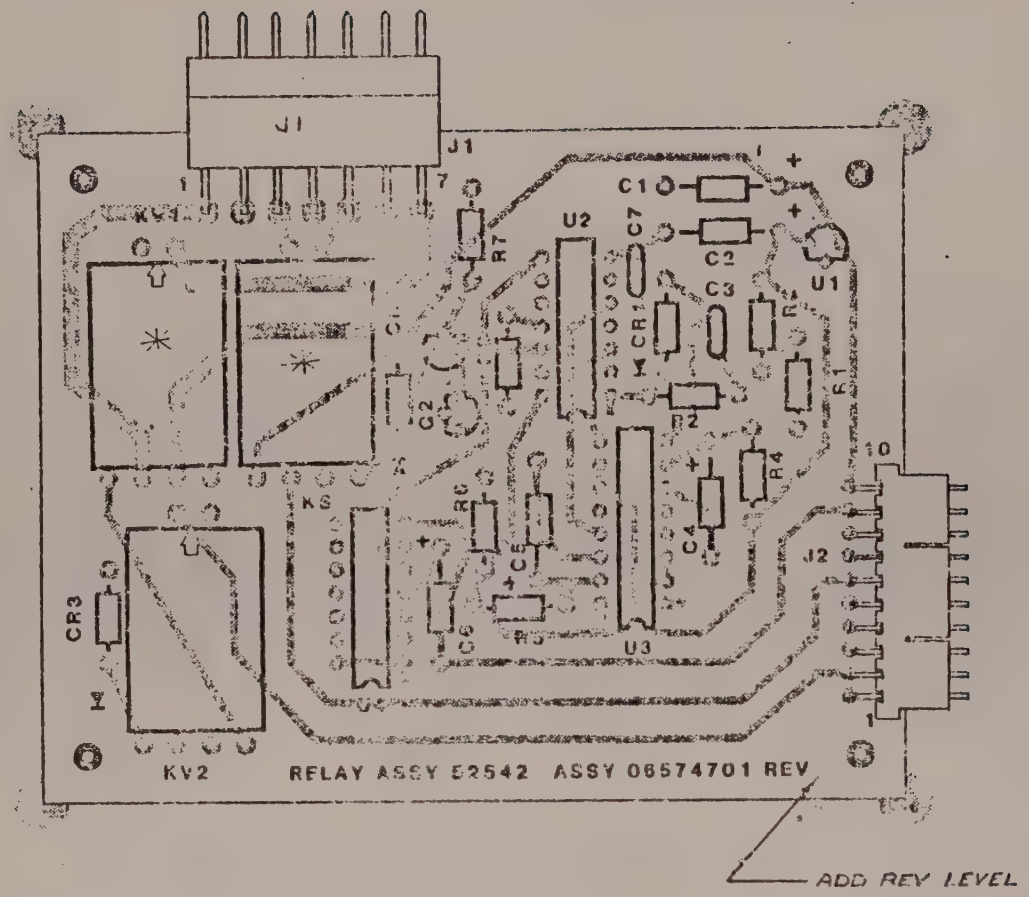


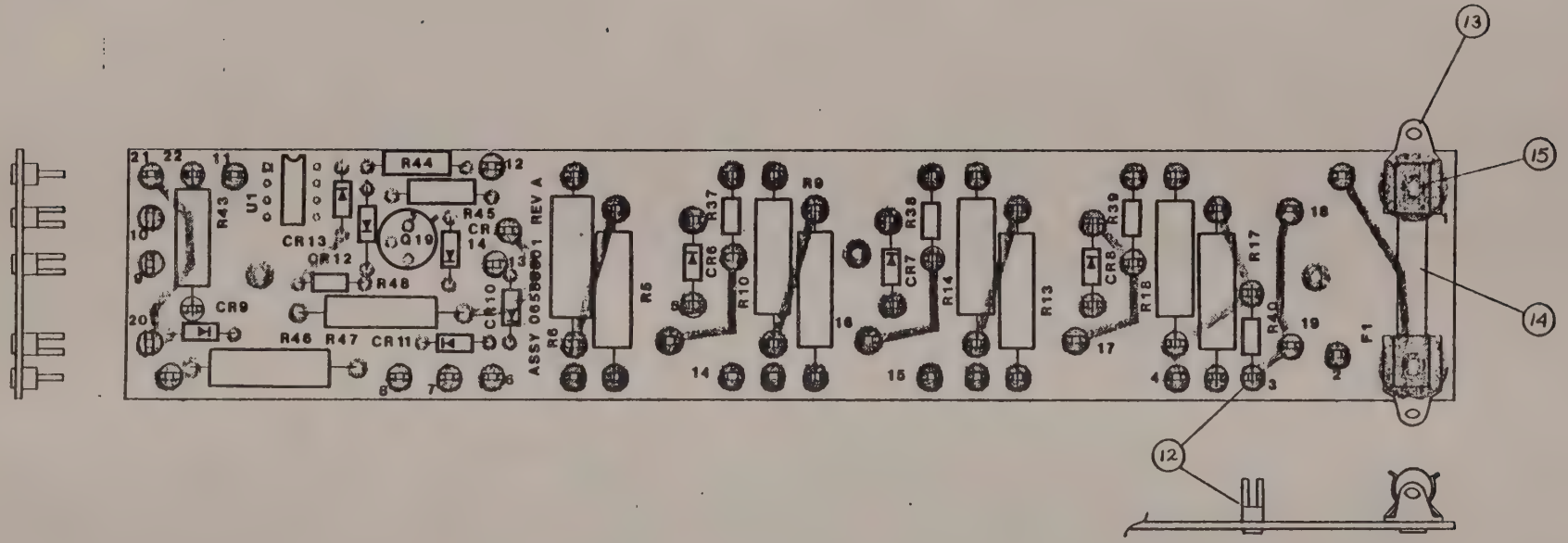
Figure 6-6
A1, Control Board PC Assembly
06582901 Rev E



*NOTE:

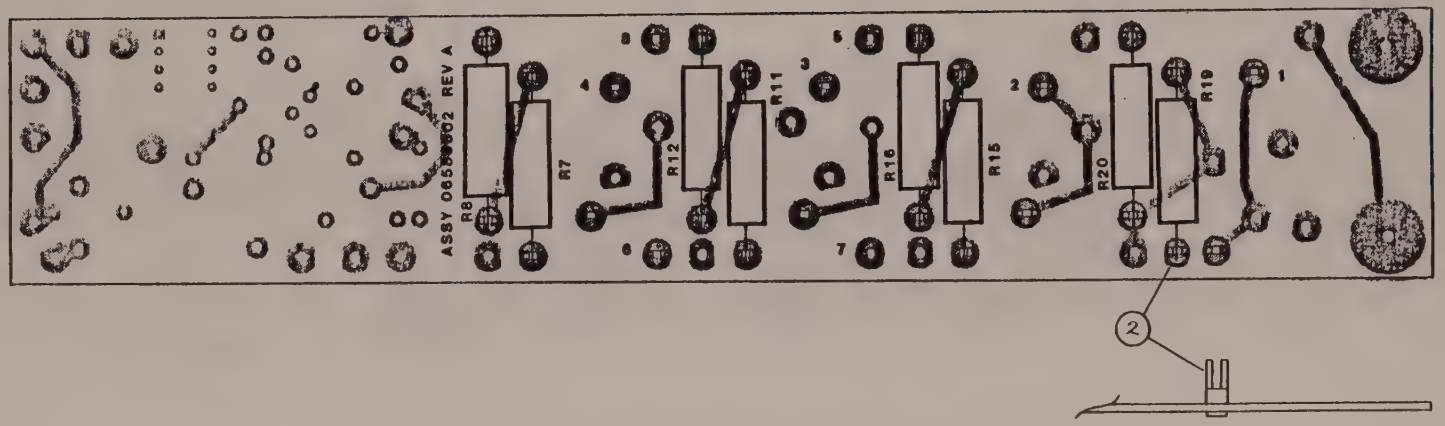
CR2 & CR3 TO BE INSTALLED IF RELAY K5, KV1 & KV2 ARE MISSING THE LETTER D FROM PART NO.

Figure 6-7
A3, Relay Board PC Assembly
06574701 Rev c



NOTE - 3 WATT RESISTORS MUST HAVE STRAIN RELIEF

Figure 6-8
A5, Series Pass Heat Sink
PC Assembly 06588501 Rev C



NOTE - 3 WATT RESISTORS MUST HAVE STRAIN RELIEF

Figure 6-9
A6, Series Pass Heat Sink
PC Assembly 06588502 Rev A

Figure
A2. Re
er

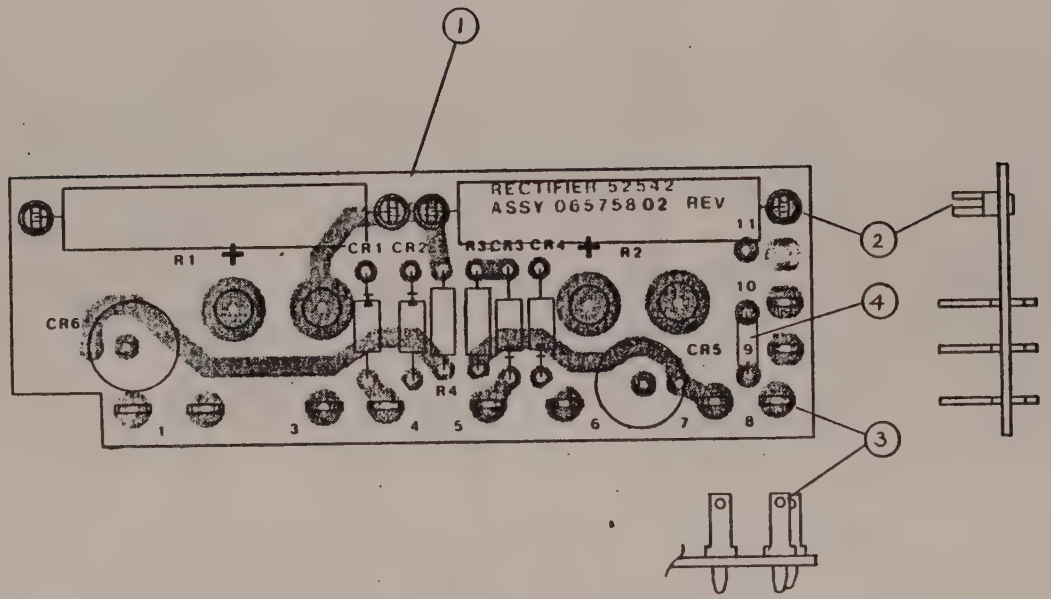


Figure 6-11
A4, Rectifier PC Assembly
06575802 Rev B

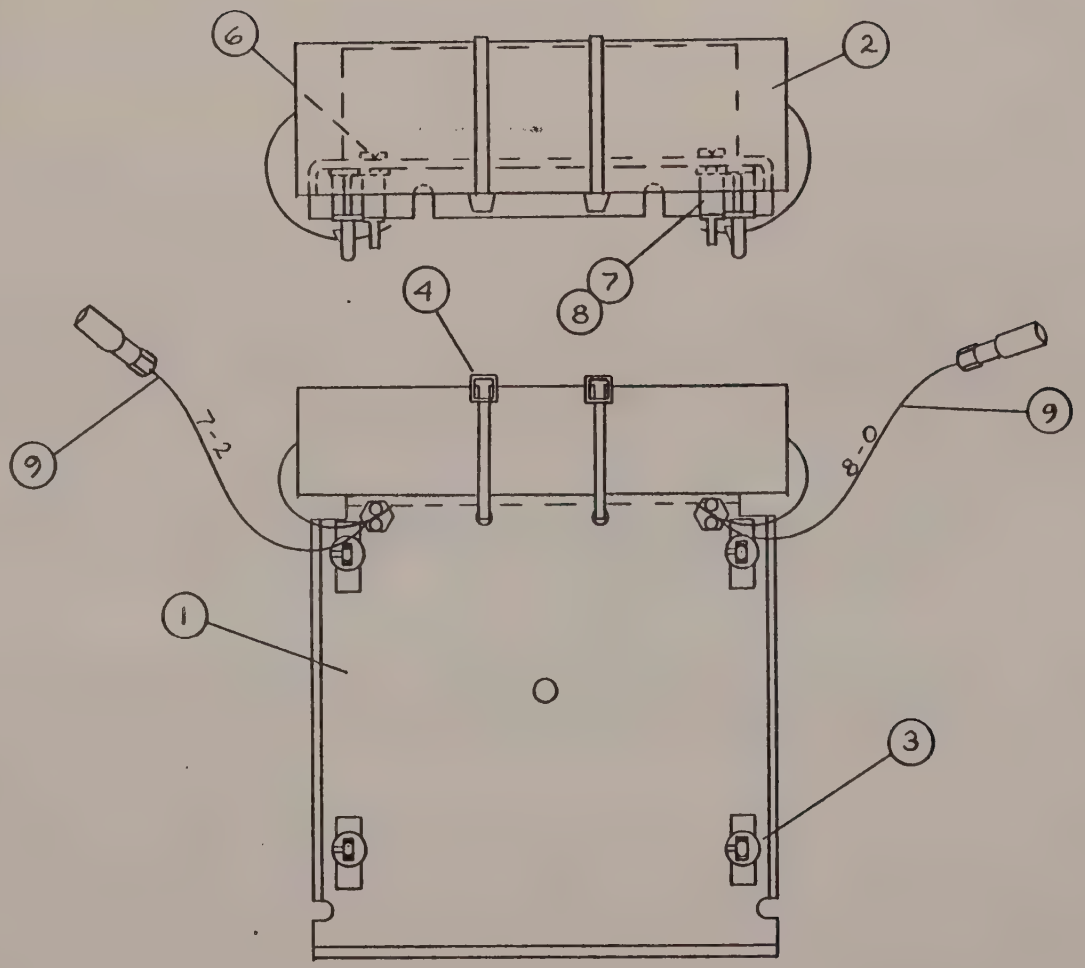


Figure 6-12
Relay Bracket Assembly
06597101 Rev B

NOTES 1) BRKTS TO BE RIVETED IN FAB SHOP.

2) EXTEND SHRINK TUBING 1/2" BEYOND CAP. CLAMP. WHILE USING HEATGUN TO SHRINK TUBING CLAMP THE ENDS WITH LONG NOSE PLIERS.

3) AFTER SHRINK TUBING IS ON CAP. BRKTS APPLY SILICONE COMPOUND G-635 ON INSIDE SURFACE.

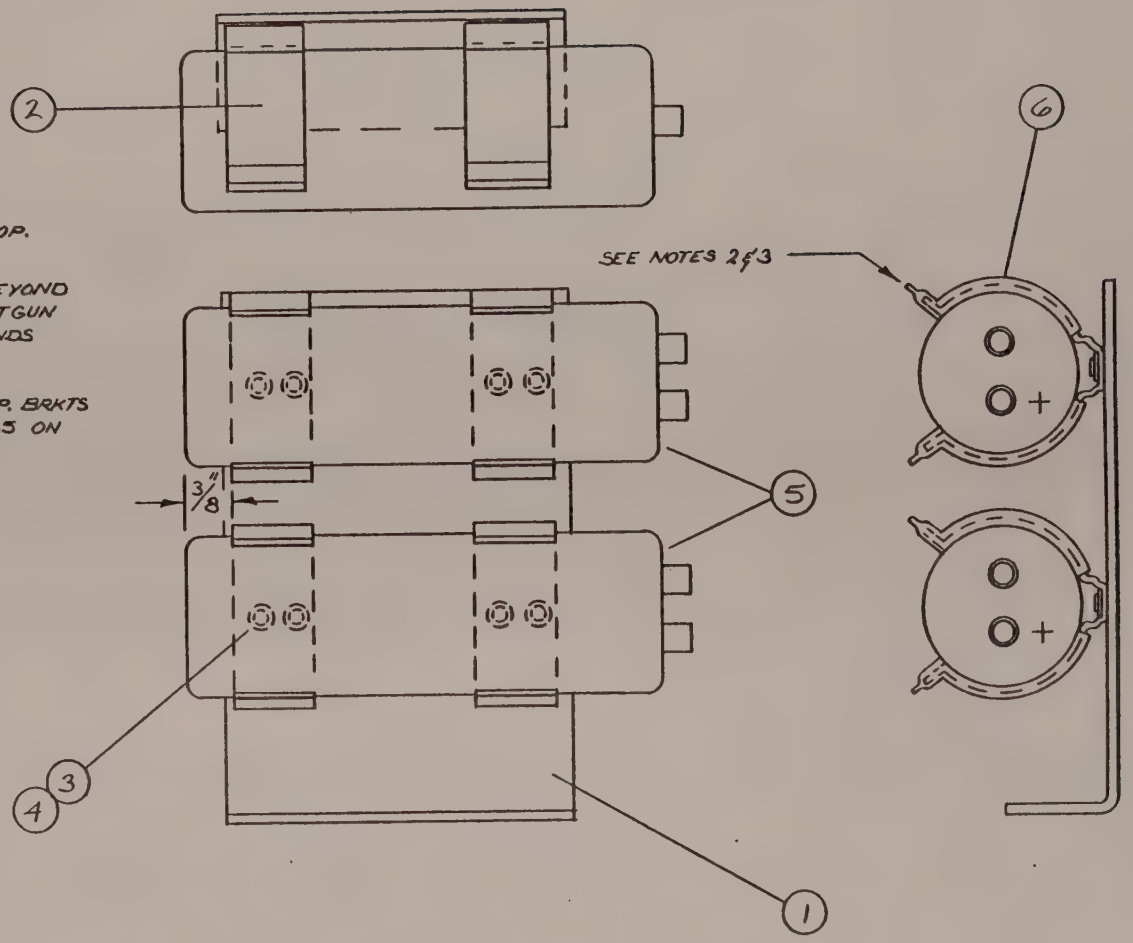
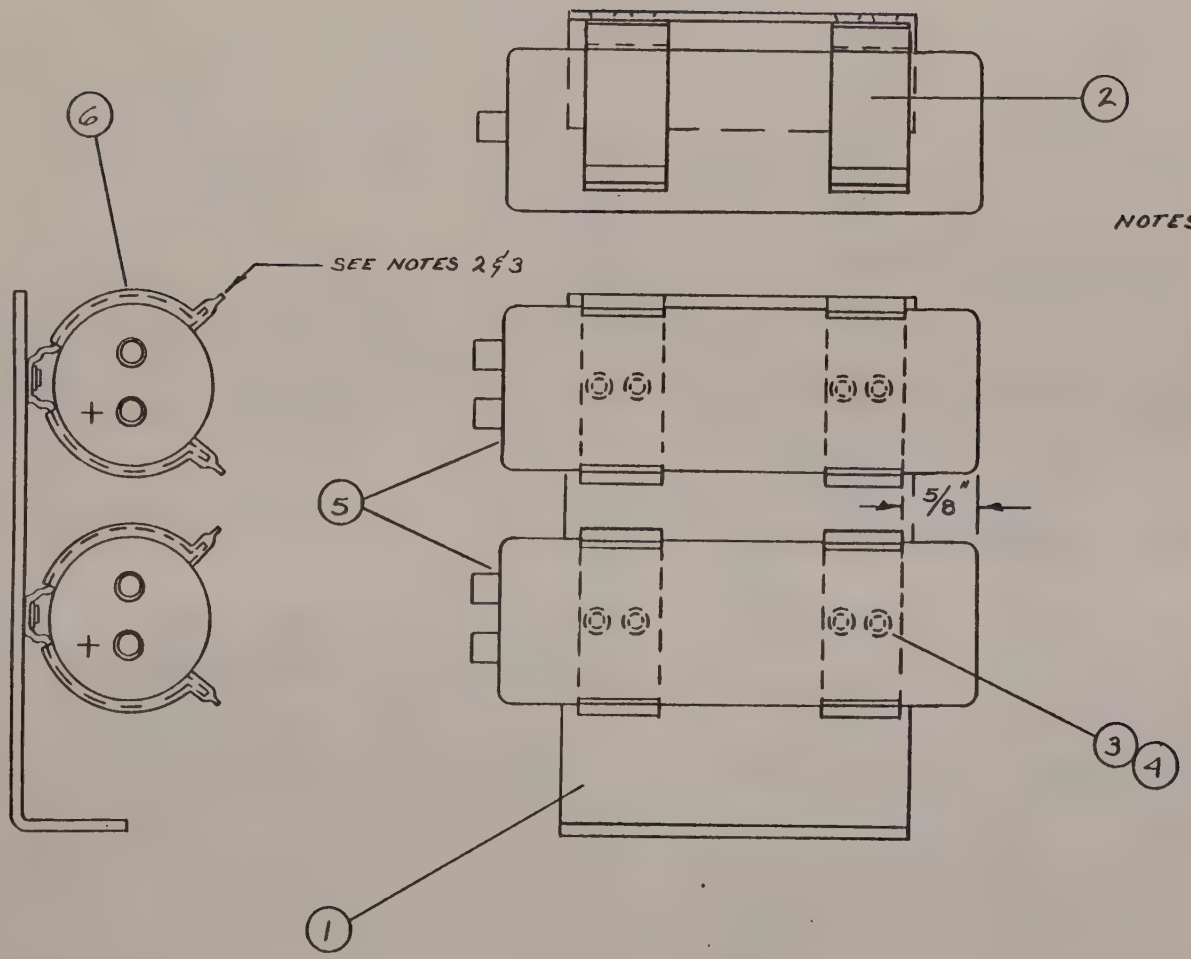


Figure 6-13
Capacitor Bracket Assembly
06597401 Rev A



NOTES 1) BRKTS TO BE RIVETED IN FAB SHOP.

2) EXTEND SHRINK TUBING 1/2" BEYOND CAP. CLAMP. WHILE USING HEATGUN TO SHRINK TUBING CLAMP THE ENDS WITH LONG NOSE PLIERS.

3) AFTER SHRINK TUBING IS ON CAP. BRKTS APPLY SILICONE COMPOUND G-635 ON INSIDE SURFACE.

Figure 6-14
Capacitor Bracket Assembly
06597402 Rev A

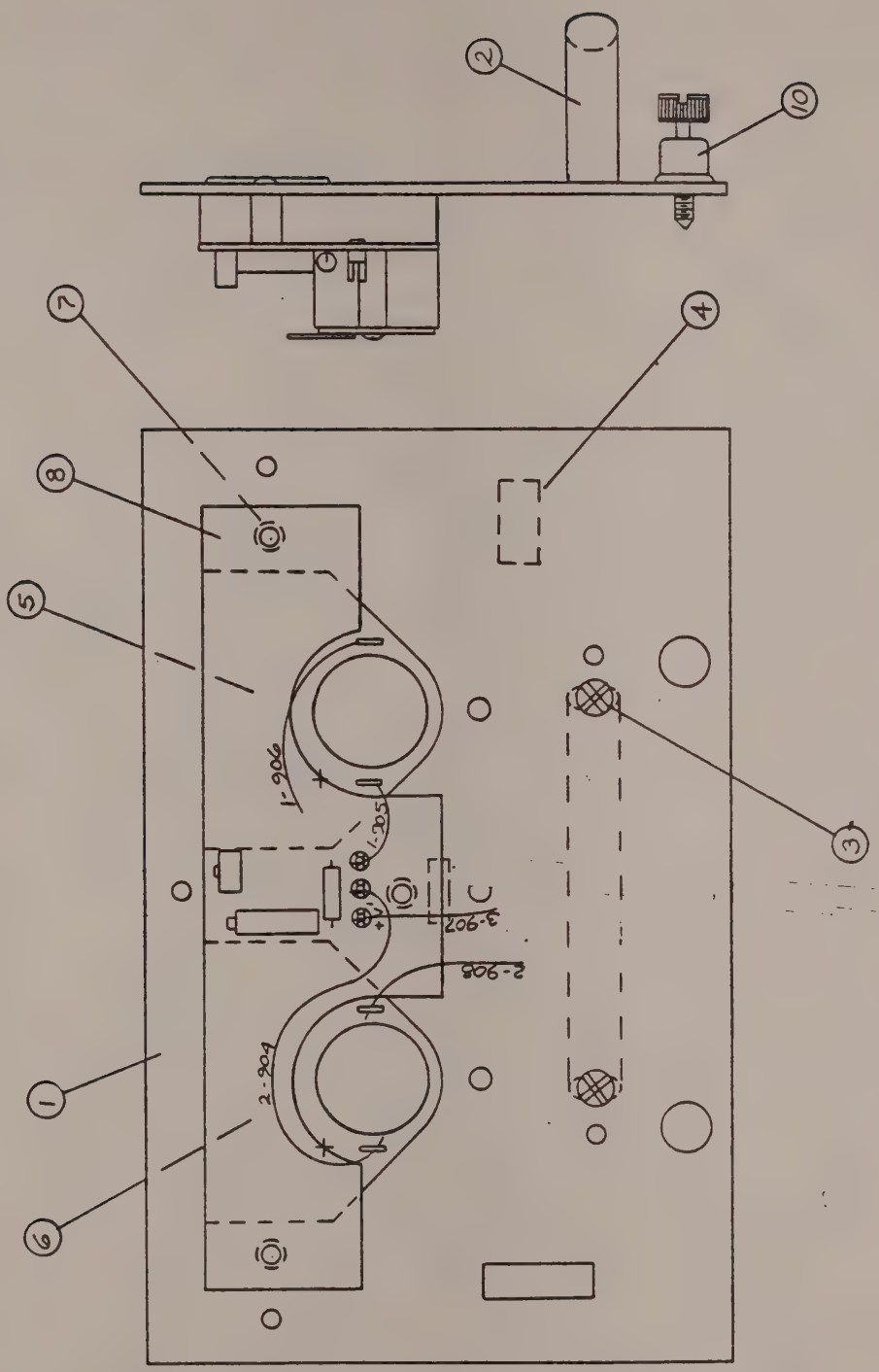


Figure 6-15
Front Panel Meter Assembly
06584301 Rev C

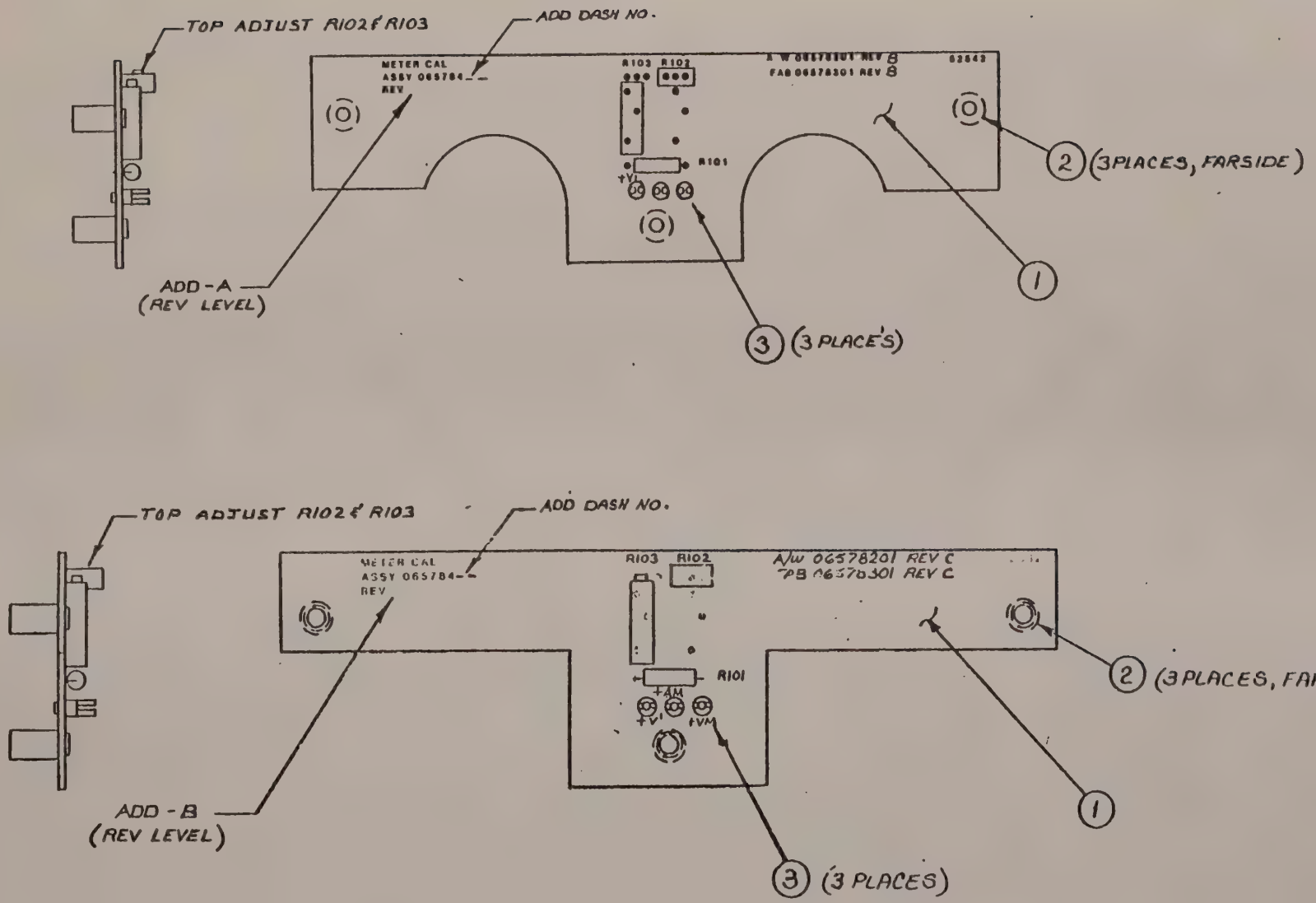


Figure 6-16
Meter Calibration PC Assembly
06578401 Rev A and Rev B

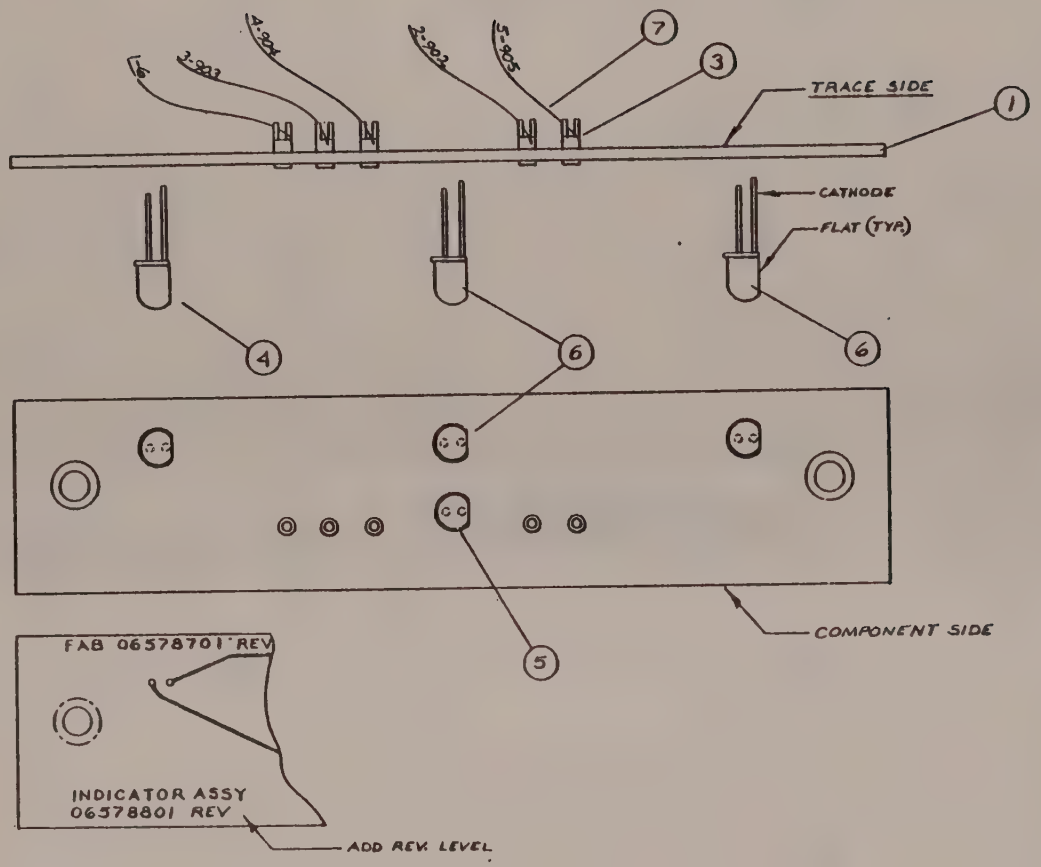


Figure 6-17
Indicator PC Assembly
06578801 Rev A

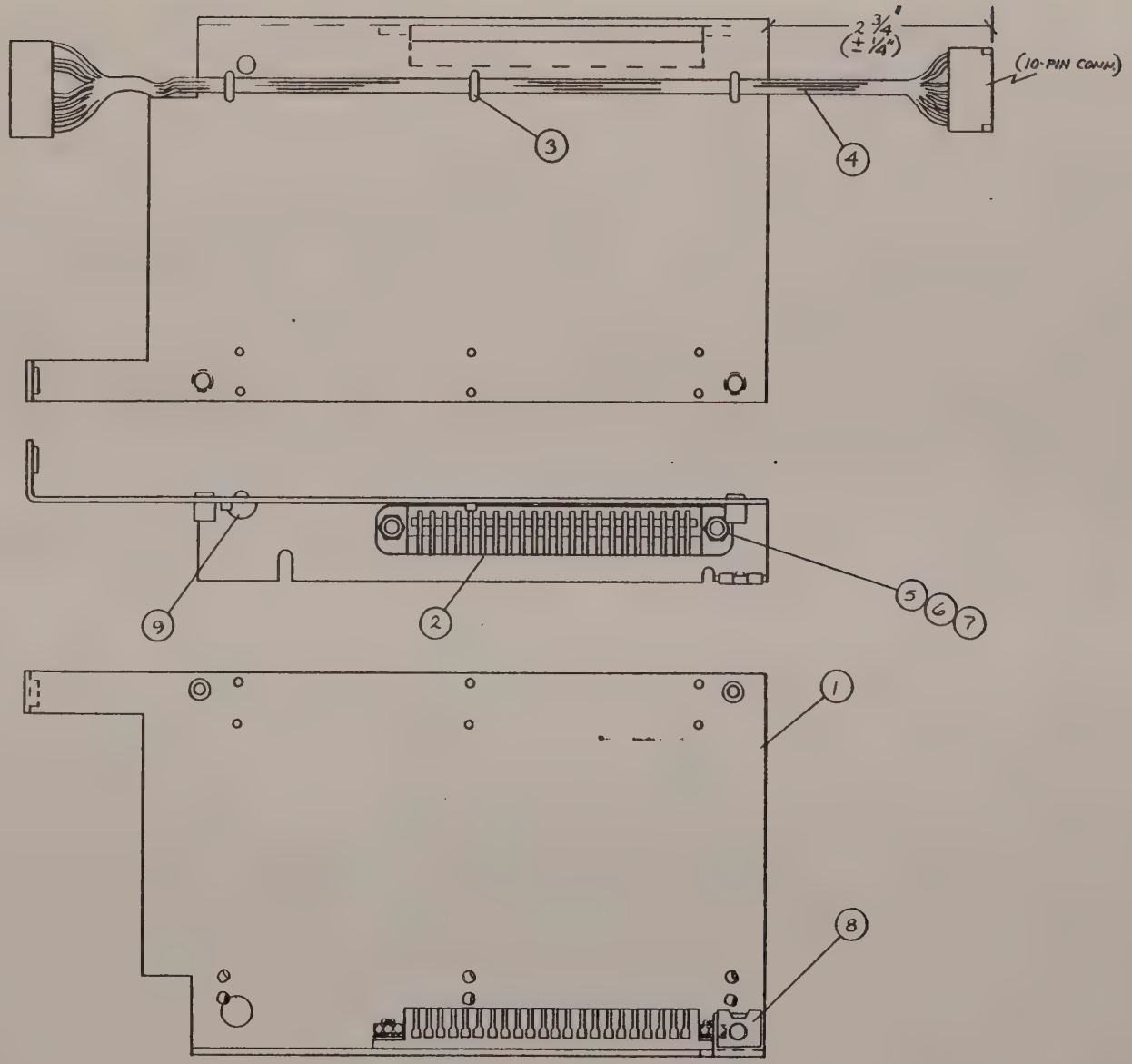


Figure 6-18
Control Board Bracket Support Assembly
06583101 Rev A

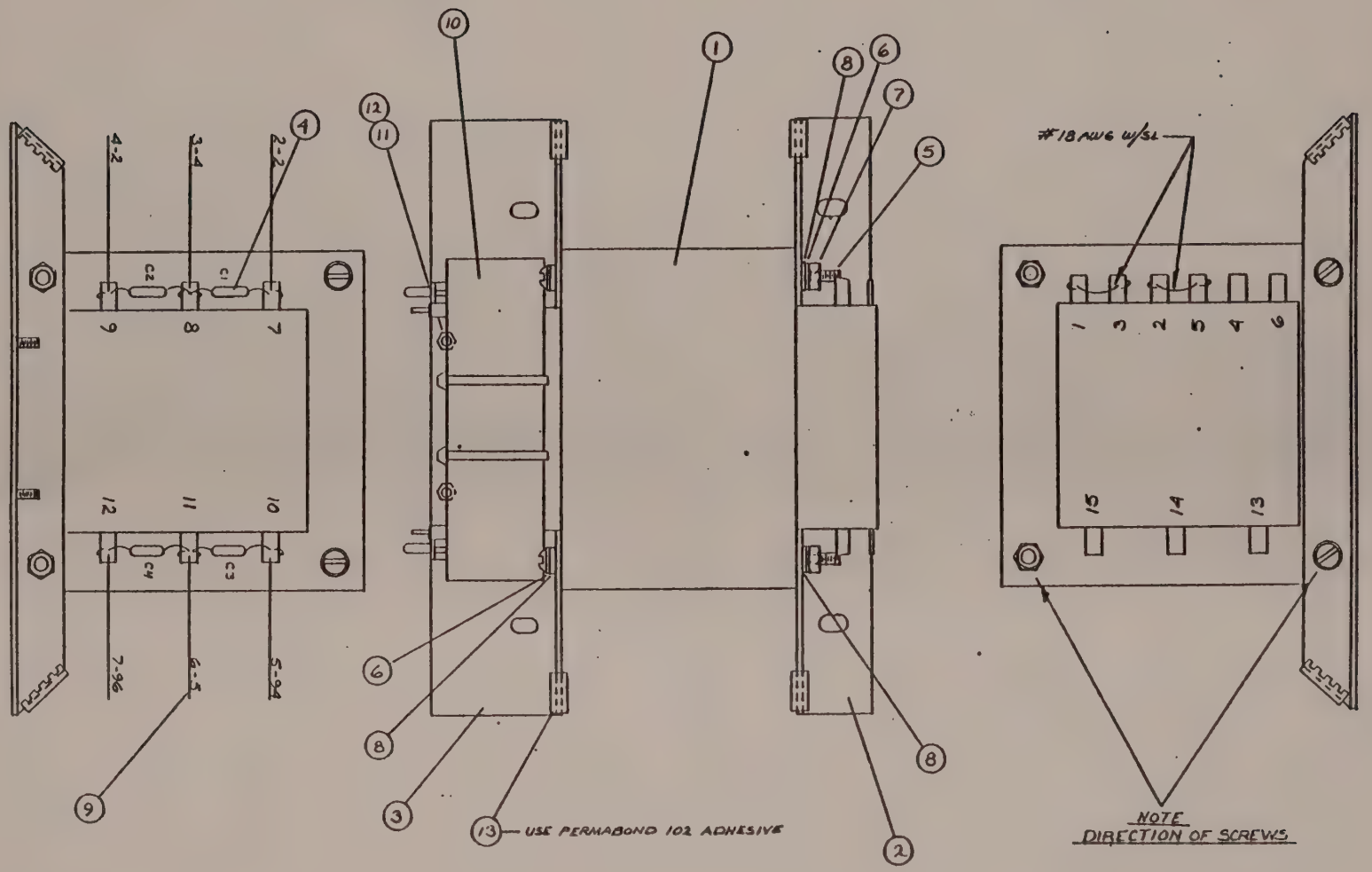
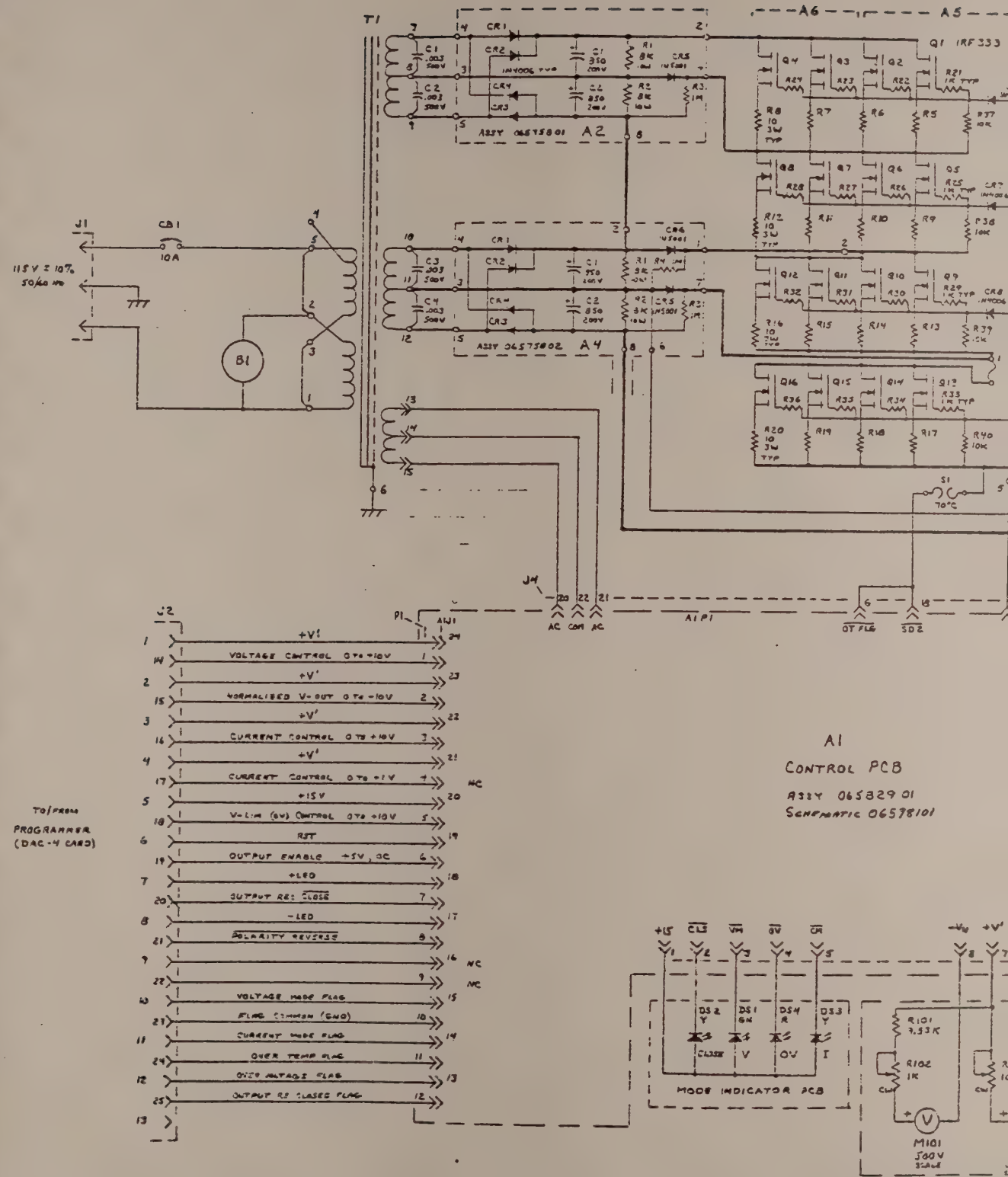


Figure 6-19
Main Transformer Assembly
06597301 Rev B


A1
CONTROL PCB
A33Y 065829 01
SCHEMATIC 06578101
A2 A33Y 06575801
A4 A33Y 06575802
T1
J1
CB1
10A
115V ± 10% 50/60 Hz
B1
J2
P1
A1J1
A1P1
J4
AC COM AC
OT FLG
SD2
S1
70°C
+V1
VOLTAGE CONTROL 0 TO +10V
NORMALISED V-OUT 0 TO +10V
CURRENT CONTROL 0 TO +10V
CURRENT CONTROL 0 TO +1V
+15V
V-LIM (0V) CONTROL 0 TO +10V
RST
OUTPUT ENABLE +5V, DC
+LED
OUTPUT RELAY CLOSE
-LED
POLARITY REVERSE
VOLTAGE MODE FLAG
FLAG COMMON (GND)
CURRENT MODE FLAG
OVER TEMP FLAG
OVER VOLTAGE FLAG
OUTPUT RELAY CLOSED FLAG
NC
To/From PROGRAMMER (DAC-4 CARD)
MODE INDICATOR PCB
DS2 Y
DS1 GR
DS4 R
DS3 Y
CV
V
OV
I
R101 3.53K
R102 1K
M1101 50V
METER OPT

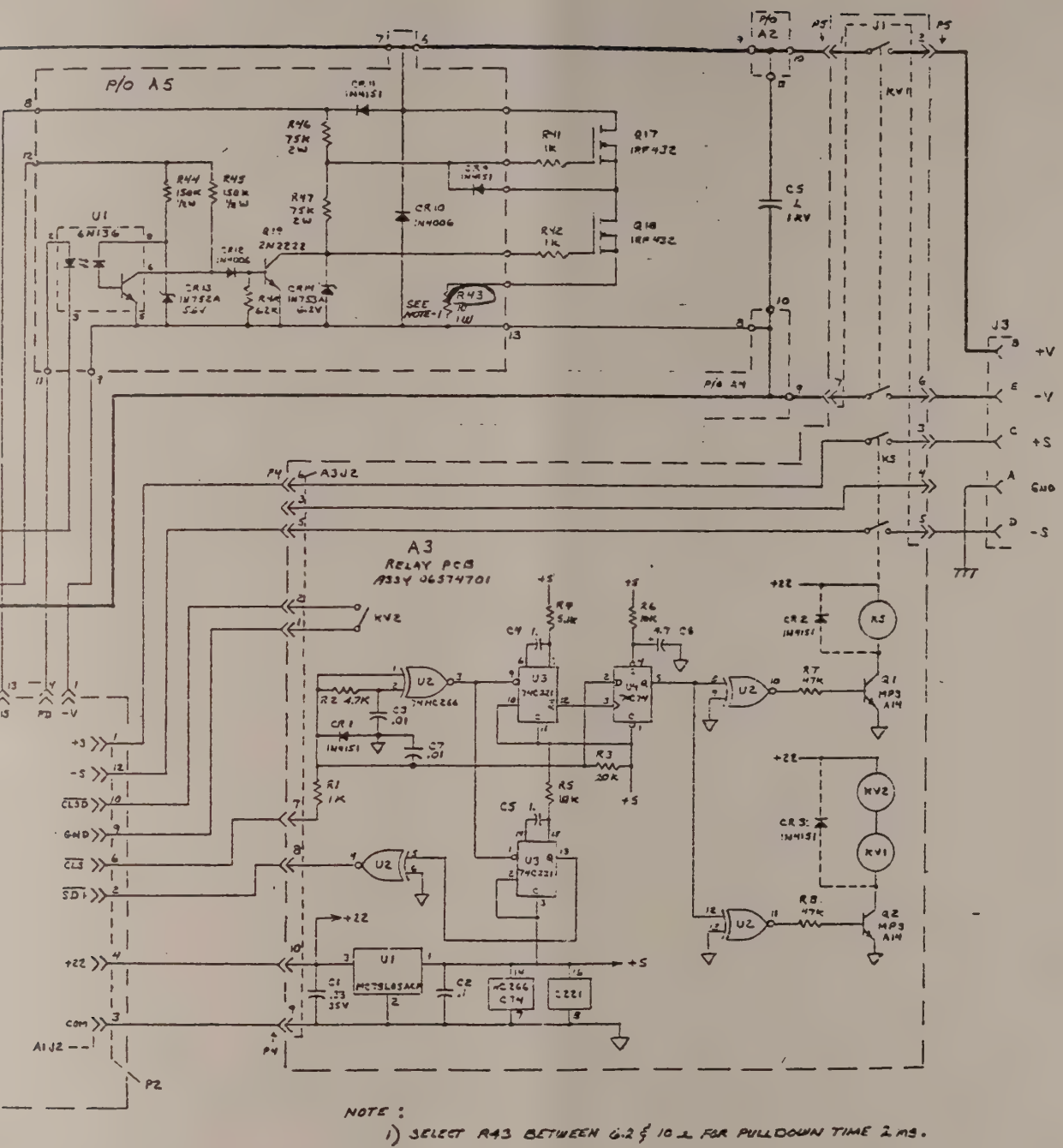
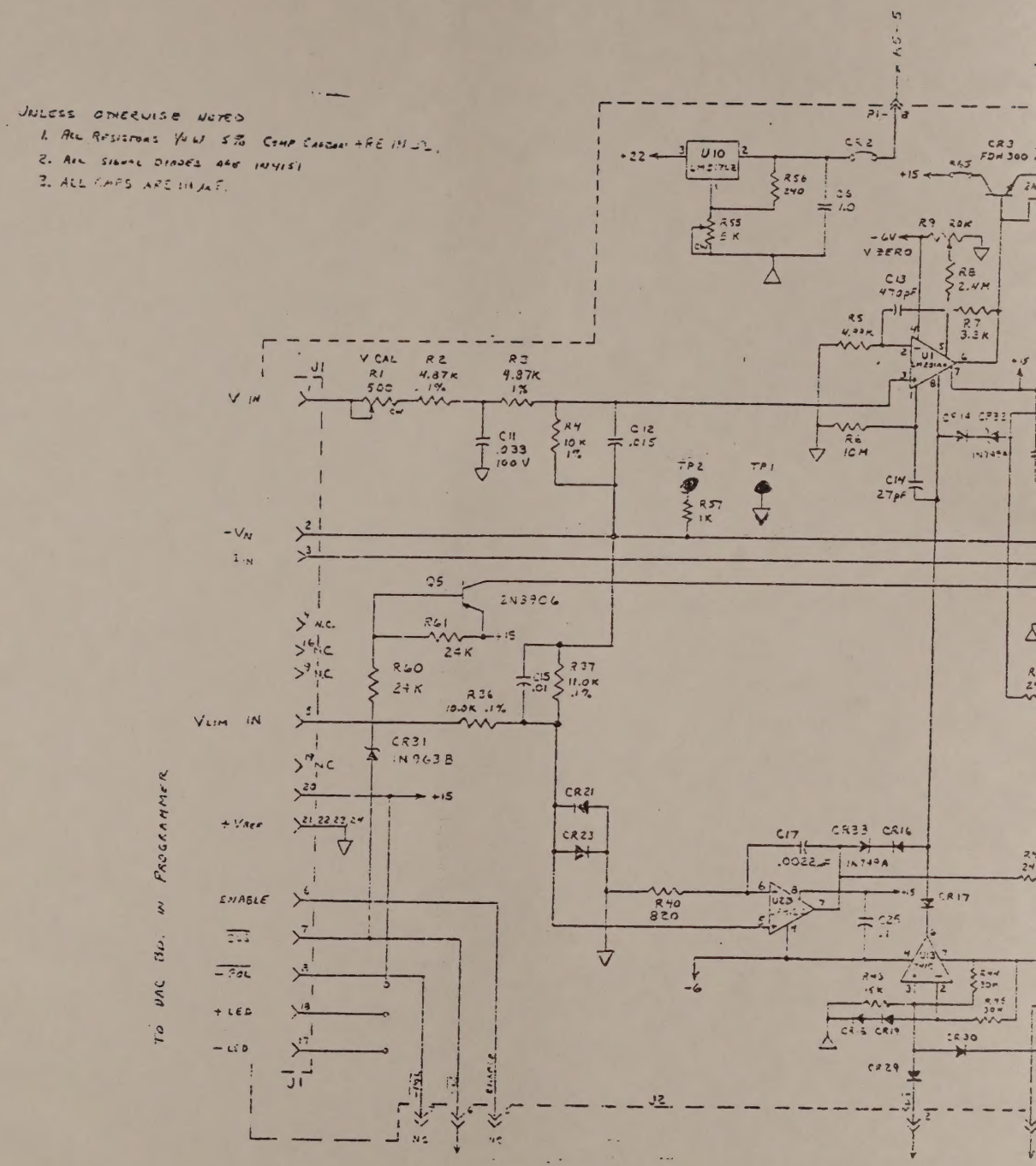


Figure 6-20
HFP500-1 Schematic
065749 Rev C


UNLESS OTHERWISE NOTED
1. ALL RESISTORS ¼W 5% COMP CARBON ARE IN Ω.
2. ALL SIGNAL DIODES ARE 1N4151
3. ALL CAPS ARE IN μF.
U10
LM317LZ
CR2
CR3
FDH 300
R56 240
C6 1.0
R55 5K
R9 20K
-6V
V ZERO
R8 2.4M
C13 470pF
R7 3.3K
R5 4.99K
U1
LM231AH
J1
V CAL
R1 500
R2 4.87K 1%
R3 4.87K 1%
V IN
C11 .033 100V
R4 10K 1%
C12 .015
R6 10M
CR14 CR32
IN749A
TP2
TP1
R57 1K
C14 27pF
-VIN
IIN
Q5
2N3906
N.C.
R61 24K
+15
R60 24K
C15 .01
R37 11.0K .1%
R36 10.0K .1%
VLIM IN
CR31
IN963B
CR21
CR23
C17 .0022
CR33 CR16
IN749A
R40 820
U23
CR17
C25 .1
-6
R43 15K
R44 30K
R45 30K
CR18 CR19
CR30
CR29
+VREF
ENABLE
-SOL
+LED
-LED
TO DAC BD. IN PROGRAMMER
J2
A-5-5

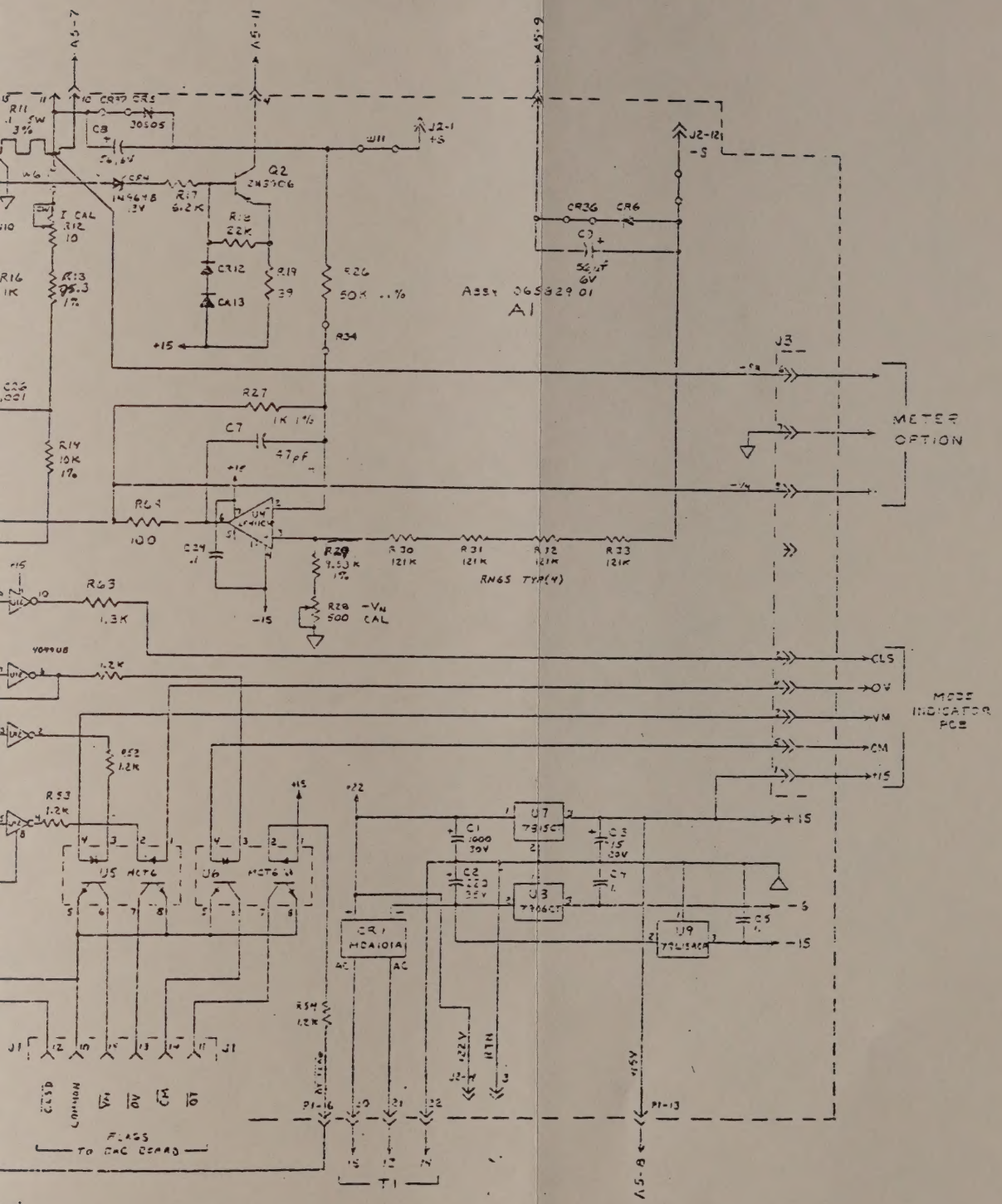


Figure 6-21
A1, Control PC Assembly Schematic
06598101 Rev C